

# **Final Report Health and Safety Plan**

## **Phase I RCRA Facility Investigation/ Remedial Investigation Operable Unit No. 4**

Prepared for  
U.S. DEPARTMENT OF ENERGY

EG&G Rocky Flats Plant  
Golden, Colorado

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**ROCKY FLATS PLANT  
FINAL REPORT  
HEALTH AND SAFETY PLAN  
FOR OPERABLE UNIT 4,  
SOLAR EVAPORATION PONDS**

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EG&G ROCKY FLATS PLANT  
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APPROVED BY:

  
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Associate General Manager  
Environmental Restoration

9-6-94  
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Date

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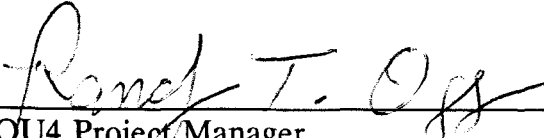
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OU4 Project Manager  
Environmental Restoration Management

8/31/94  
Date

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## 1.0 GENERAL INFORMATION

This site specific Health and Safety Plan (HASP) has been prepared in conformance with requirements of the Occupational Safety and Health Administration (OSHA) Title 29 Code of Federal Regulations (CFR) Part 1910.120 - Hazardous Waste Operations and Emergency Response, OSHA 29 CFR 1910.1200 - Hazard Communication, Department of Energy (DOE) regulations, and EG&G Standard Operating Procedures (SOPs). In addition, this plan complies with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Resource Conservation and Recovery Act (RCRA). This HASP represents the minimum health, safety, and emergency response activities required for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) for Operable Unit Number 4 (OU4) at the EG&G Rocky Flats Plant (RFP) in Golden, Colorado. The OU4 site is on the U.S. Environmental Protection Agency's (EPA) Superfund National Priorities List. Compliance with this HASP is required of all personnel working at or visiting the RFI/RI site, including all employees and subcontractors of EG&G.

The purpose of the RFI/RI is to characterize soil contamination around the Solar Ponds and under the pond liners and determine risk of the contamination. In addition, this project

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will attempt to delineate the original pond area location. Lastly, the RFI/RI will try to determine where underground objects, powerlines, and pipelines are located in the Solar Pond area.

The purpose of this HASP is to detail the health, safety, accident, and fire protection standards and procedures to be used during the course of the RFI/RI; outline standard operating procedures to ensure the health and safety of all personnel performing activities connected to the project; outline emergency and contingency plans for protection of personnel and for any contingencies which might also affect the surrounding populace and environment; and designate the responsibilities and authorities for implementing this HASP, as well as reporting procedures.

All employees who work on this project must be familiar with the information, instructions, and emergency response actions contained in this HASP. All employees directly involved in RFI/RI field activities must read this HASP and sign a statement included in Appendix A, prior to participating in any field activity, indicating they have read and understand this HASP. Any modifications to this HASP will be presented to project personnel involved in field activities during safety briefings. The safety briefings will be documented and the modifications incorporated into this HASP.

The HASP shall be available for inspection and review by all personnel participating in the RFI/RI field activities; authorized EG&G personnel; representatives for DOE, EPA, OSHA, and the State of Colorado; and other authorized visitors. A copy of the HASP shall be readily available during field activities.

All field team members will be qualified by the Project Manager (PM) and Project Health and Safety Manager (PHSM) prior to participating in RFI/RI field activities at RFP to verify that required training and medical surveillance has been completed.

### 1.1 REFERENCES, REGULATIONS, AND GUIDELINES

This HASP and all RFI/RI field activities conducted throughout OU4 and the Solar Evaporation Ponds area will be in compliance with the requirements of the most current edition of the following documents:

- U.S. Department of Energy Regulations;
- U.S. Department of Labor, OSHA Standards  
29 CFR Part 1910, specifically 29 CFR 1910.120 and 29 CFR 1010.1200;
- U.S. Environmental Protection Agency, Standard Operating Safety Guidelines  
July 1988;
- National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA, Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities  
October 1985;
- EG&G Health and Safety Practices Manual;
- EG&G Standard Operating Procedures; and
- Field Sampling and Geophysical Investigation of the Existing Solar Ponds Area.

### 1.2 SCOPE OF SERVICES

The scope of services to be covered by this HASP for the RFI/RI field sampling project at RFP are briefly summarized below.

- OU-wide radiological survey and surficial soil sampling;

- OU-wide vadose zone monitoring;
- Field sampling and geophysical investigation in the vicinity of the Original pond;
- Field sampling and geophysical investigation of the existing Solar Ponds area; and
- Field sampling and investigation of the Interceptor Trench system and site remainder.

### **1.3 FIELD CHANGES**

A Field Change form is included in Appendix B. Any employee or subcontractor working on the OU4 RFI/RI can initiate a change in the HASP by filling out the Field Change Form and submitting it to the Project Health and Safety Manager (PHSM). This form must then be signed by the PHSM, Program Manager (PrM), and Project Manager (PM). Before the field change becomes final, signatures must also be obtained from the EG&G Health and Safety Liaison Officer and the EG&G Project Manager.

Once the change is approved, the Field Change Form must be incorporated into the HASP in the appropriate section.

### **1.4 HASP CONTENTS AND ORGANIZATION**

The HASP includes the following information:

- Staff organization and responsibilities - Section 2.0;
- Site description and contamination characterization - Sections 5.0, 6.0, and 7.0;
- Hazard Assessment, Levels of Protection, and Action Levels - Sections 6.0, 7.0, and 10.0;
- Accident Prevention - Section 13.0;
- Heat and cold stress monitoring - Sections 6.0 and 16.0;

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- Site control measures - Section 14.0;
- Personal hygiene and decontamination - Section 11.0;
- Personal and environmental monitoring - Section 8.0;
- Medical surveillance - Section 16.0;
- General and site-specific training - Section 9.0;
- First aid and emergency equipment - Section 17.0;
- Emergency response and contingency plan - Section 17.0;
- Standard operating procedures - Section 18.0; and
- Logs, reports, and record keeping - Section 20.0.

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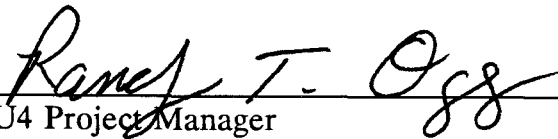
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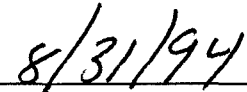
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OU4 Project Manager  
Environmental Restoration Management

  
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Date

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## 2.0 PROJECT ORGANIZATION

### 2.1 PERSONNEL RESOURCES

The project team is comprised of a senior technical program and project manager, senior advisors, project support personnel, and project technical support personnel. A summary of technical qualifications of contractor personnel, roles and responsibilities, company and contact telephone, and pagers and FAX numbers for each individual should be provided.

A senior advisory team will be established for the project and responsible for the technical quality of the entire project. This team is comprised of senior level individuals with extensive experience in the technical areas that will be required for the project. Advisory team members will provide technical expertise during the implementation of the field tasks and overall project assignments as well as review all work products produced during the entire project.

Project support personnel will be responsible for all administrative issues, overall Quality Assurance/Quality Control (QA/QC), and health and safety. Administrative personnel will be responsible for budget and schedule tracking, contractual budget reports, data management and Geographic Information System (GIS) input.



Project technical support personnel should include a project engineer, hydrogeologist, geochemist, certified industrial hygienist, or health physicist and toxicologist. Each individual will have direct responsibility for their respective technical areas throughout the entire project. Additional technical resources should include the field team leader, and project health and safety officers as needed to fulfill project requirements.

An appropriate number of subcontractors should be included in the project team, as necessary, to provide additional technical expertise. A recommended listing of the subcontractors, their addresses and phone numbers, the name of the contact person, and a description of the responsibilities of each subcontractor should be presented in a table format within this chapter.

Table 2.1 provides a list of key EG&G personnel, their title, telephone number, and pager number.

## **2.2 PROGRAM MANAGER**

The Program Manager (PrM) is primarily responsible for overall technical performance and the administrative management of all tasks that will be conducted during the performance of the OU4 Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI). The PrM has the complete authority for commitment of resources for any task.

The PrM also has overall responsibility for safety during the site activities. Her responsibilities include:

- Coordinating preparation of an effective, approved site health and safety plan for the project;

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**TABLE 2.1  
EG&G MANAGEMENT AND PERSONNEL FOR THE OU4 RFI/RI**

<b>Name</b>	<b>Title</b>	<b>Telephone Number</b>	<b>Pager Number</b>
Randy Ogg	Project Manager	966-8608	5472
Marla Broussard	Operations Manager	966-8517	4010
Keith Anderson	Radiological Engineering Representative	966-5151	3296
Lisa LeLievre	Health and Safety Liaison Officer	966-7691	5390
Brian Fielding	Site Health and Safety Coordinator/Industrial Hygiene Representative	966-5471	3063
Jim Fitzimons	Permitting and Compliance Representative	966-6264	1497
Dr. Furman	Occupational Health Director	966-2985	2356
Keith Miller	Fire Protection Representative	966-6042	0024
Steve Balint	Operational Meteorologist	966-2453	-
Pat Stephens	Health and Safety Area Management Representative	966-4813	3307
Doug Perryman	Industrial Safety Representative	966-5827	1655

- Characterizing the potential specific chemical and physical hazards which may be encountered in the conduct of the RFP in conjunction with the SSHO and the PHSM;
- Determining the levels of potential employee exposure to hazardous materials;
- Assuring that adequate and appropriate health and safety training and equipment are available for project personnel;
- Arranging for medical examinations for specified project personnel, if necessary; and
- Designating a PHSM.

### **2.3 DEPUTY PROGRAM MANAGER**

The deputy program manager will report directly to the PrM and be responsible for the day-to-day conduct of the project. The deputy program manager will also be responsible for coordinating the specified portions of the project and can perform PrM duties in her absence. These two individuals are the primary contacts for the project team along with an EG&G OU4 Project Manager.

### **2.4 PROJECT MANAGERS**

Due to the size and complexity of the implementation of the RFI/RI, it may be necessary to assign two overall project managers and three deputy project managers. A registered professional geologist should be responsible for the implementation of the RFI/RI field program, preparation of technical memoranda related to project activities, and preparation of the report. Additional technical support will be provided as needed to assist with the implementation of the field program. A certified industrial hygienist (CIH) will be responsible for the overall completion of the health and safety aspects of the project. A deputy project manager may be added to the team as necessary to support day-to-day field

activities. The CIH and the deputy project manager will be assisted by technical support staff.

## **2.5 FIELD TEAM LEADER**

The field team leader and project hydrogeologist will be responsible for the following:

- Conduct of day-to-day activities during the RFI/RI implementation;
- Conduct plan of the Day (POD) meetings;
- Interaction with other subcontractors working in the area;
- Arranging for escorts for uncleared personnel;
- Determination of borehole placement;
- Resolution of other logistical problems;
- Temporary suspension of field activities, if health and safety of personnel are endangered, pending an evaluation by the PHSM and/or the SSHO; and
- Temporary suspension of an individual from field activities for infraction of this HASP, pending an evaluation by the PrM, the PHSM, the SSHO, and the employee's supervisor.

## **2.6 PROJECT HEALTH AND SAFETY MANAGER**

An RFI/RI PHSM will be assigned prior to the initiation of field activities. The PHSM has overall responsibility for development and implementation of this HASP and conformance with applicable health and safety regulations. The PHSM will be the primary contact for matters relating to health and safety. The PHSM will be consulted when any changes to this HASP or modifications of any procedures are required or requested, or when any new activities not delineated in this HASP are proposed. The PHSM will be responsible for the development of any new health and safety protocols and procedures necessary for new field

operations and will also be responsible for the resolution of any outstanding health and safety issues which arise during the conduct of site work. When required, the PHSM will revise this HASP or prepare amendments for new operations. The PHSM or his designate will approve the health and safety qualifications of the contractor and subcontractor employees to fill designated health and safety roles during field activities. Authorization for personnel to perform work onsite relative to employee training and medical surveillance policies must be cleared ahead of time with the PHSM. The PHSM will maintain a task record which includes all information relative to site accidents, injuries, or incidents.

## **2.7 SITE SAFETY AND HEALTH OFFICER**

An SSHO for all RFI/RI activities will be assigned prior to the initiation of field activities. This person will be responsible for the proper implementation of this HASP during RFI/RI activities. The responsibilities of the SSHO or a designated representative include:

- Overseeing all activities to ensure compliance with this HASP;
- Coordinating activities with EG&G personnel present on the site;
- Conducting daily safety briefings as needed for all contractor and subcontractor personnel performing construction activities;
- Verifying that communication systems are in place;
- Managing health and safety equipment (e.g., respirators, instruments, boots, gloves, suits, etc.), used during field activities;
- Supervising and overseeing the activities of the Environmental Health and Safety Specialist (EHSS);
- Processing Radiation Work Permits and Radiological Deficiency Reports (copies of these forms are located in Appendix M);
- Establishing work/rest regimen;

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- Arranging for emergency response provisions in conjunction with local authorities (e.g., hospital, fire, police);
- Monitoring and inspecting health and safety conditions during RFI/RI activities and deciding when more stringent personal protection equipment is required;
- Maintaining a daily safety log to record weather conditions, personnel involved in field activities, safety problems, and any other pertinent health and safety information;
- Overseeing the setup, inspection, and execution of equipment and personnel decontamination;
- Providing EG&G personnel with information regarding the planned field activities as needed;
- Notifying EG&G representatives of emergencies related to the RFI/RI activities;
- Reporting health and safety violations or problems to the PHSM; and
- Controlling visitor access to the potentially hazardous areas of the site.

EG&G and the SSHO have the authority to stop field activities if conditions are deemed unsafe (e.g., weather conditions). The go ahead to proceed with field activities following such an action will be determined by EG&G and the SSHO. The SSHO will also have the authority to temporarily remove any contractor or subcontractor employee from field activities if that individual is not complying with this HASP. When an incident occurs which could have resulted in an accident, injury, or loss or damage to property, the SSHO will contact the PHSM for the required documentation and reporting procedures.

The SSHO will have completed the minimum training requirements presented in Section 9.0. In addition, the SSHO or designate will hold current CPR and First Aid certification. The SSHO will have a working knowledge of federal and state regulations, as well as a positive and conscientious attitude toward health and safety.

## **2.8 ENVIRONMENTAL HEALTH AND SAFETY SPECIALIST**

The Environmental Health and Safety Specialist (EHSS) must be approved by the EG&G Industrial Hygiene and Radiological Engineering departments. This individual will be responsible for performing contaminant and noise monitoring during RFI/RI activities. The responsibilities of the EHSS will include:

- Performing all radiological monitoring duties in accordance with the Environmental Management Radiological Guidelines (EMRGs);
- Monitoring for respirable dust concentrations utilizing the MiniRam real time aerosol monitor;
- Monitoring for organic vapors with a PID;
- Performing personal breathing zone monitoring for particulates, beryllium, and radionuclides;
- Performing radiological surveys during core logging procedures;
- Performing personal monitoring on individuals when leaving the site for lunch and at the end of the day;
- Taking smears on equipment leaving the exclusion zone;
- Periodically checking break rooms, shower rooms, and contractor trailers for radionuclide contamination;
- Taking periodic sound level measurements during noisy operations;
- Calibrating and maintaining all monitoring equipment supplied by the contractor according to the American National Standards Institute (ANSI) N. 323, and making sure all equipment supplied by EG&G is calibrated and maintained by EG&G;
- Reporting all health and safety problems observed to the SSHO;
- Setting up a decontamination station in the Contaminated Reduction Zone;

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- Assisting in the decontamination of employees and equipment; and
- Handling Radiation Work Permits and Radiological Deficiency Reports.



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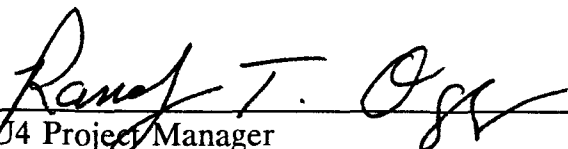
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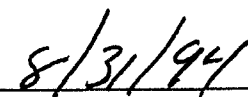
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APPROVED BY:

  
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OU4 Project Manager  
Environmental Restoration Management

  
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Date

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### 3.0 GENERAL SITE LOCATION, DESCRIPTION, AND HISTORY

Rocky Flats Plant (RFP) is located in northern Jefferson County, Colorado, approximately 15 miles northwest of Denver. Other surrounding cities include Boulder, Westminster, and Arvada, all of which are located less than 10 miles to the northwest, east, and southeast, respectively. The plant consists of approximately 6550 acres of federal land in sections 1-4 and 9-15 of T2S, R70W, 6th Principal Meridian. In general, plant buildings are located within a protected central area site of approximately 400 acres, and surrounded by a buffer zone of approximately 6150 acres. RFP is bounded on the north by State Highway 128, on the east by Jefferson County Highway 17, also known as Indiana Street, on the south by agricultural and industrial properties and Highway 72, and on the west by State Highway 93.

#### 3.1 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

The following subsections, taken from the Final RFI/RI Work Plan (U.S. DOE 1992), provide general information on RFP and the surrounding region, including RFP history, regional land use and population data, and site conditions. Site-specific conditions and the history of OU4 are addressed in Section 3.2 and Appendix C, respectively.

##### 3.1.1 Facility Background and Plant Operations

RFP is a government-owned, contractor-operated facility, which is part of the nationwide Nuclear Weapons Complex. The plant was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975.

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At that time, responsibility for the plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by the Department of Energy (DOE) in 1977. Dow Chemical U.S.A., an operating unit of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating the Rocky Flats Plant from July 1, 1975, until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor at RFP on January 1, 1990.

In the past, operations at RFP consisted of fabrication of nuclear weapons components from plutonium, uranium, and other nonradioactive metals (principally beryllium and stainless steel). In addition, the plant reprocessed components after they were removed from obsolete weapons, for recovery of plutonium. Other activities at RFP included research and development in metallurgy, machining, nondestructive testing, coating, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes were generated in the production processes. At the present time, the plant is not producing weapon components. However, environmental radiation projects are ongoing at the plant. Current waste handling practices involve onsite and offsite recycling of hazardous materials, onsite storage of hazardous and radioactive mixed wastes, and offsite disposal of solid radioactive materials at another DOE facility. However, RFP operating procedures historically included both onsite storage and disposal of hazardous, radioactive, and radioactive mixed wastes. Preliminary assessments under the Environmental Management (EM) Program identified some of the past onsite storage and disposal locations as potential sources of environmental contamination.

### **3.1.2 Previous Investigations**

Various site-wide studies have been conducted at RFP to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the

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environment. The investigations performed prior to 1986 were summarized by Rockwell International (1986a) and include the following:

1. Detailed description of the regional geology (Malde, 1955; Spencer, 1961; Scott, 1960, 1963, 1970, 1972, and 1975; Van Horn, 1972 and 1976; Dames and Moore, 1981; and Robson et al., 1981a and 1981b);
2. Several drilling programs beginning in 1960 that resulted in construction of approximately 60 monitoring wells by 1982;
3. An investigation of surface water and ground water flow systems by the U.S. Geological Survey (Hurr, 1976);
4. Environmental, ecological, and public health studies that culminated in an Environmental Impact Statement (U.S. DOE, 1980);
5. A summary report on ground water hydrology using data from 1960 to 1985 (Hydro-Search, Inc, 1985);
6. A preliminary electromagnetic survey of the plant perimeter (Hydro-Search, Inc., 1986);
7. A soil-gas survey of the plant perimeter and buffer zone (Tracer Research, Inc., 1986); and
8. Routine environmental monitoring programs addressing air, surface water, ground water, and soils (Rockwell International, 1975 through 1985, and 1986b).

In 1986, two major investigations were completed at the plant. The first was the DOE Comprehensive Environmental Assessment and Response Program (CEARP) Phase I Installation Assessment (U.S. DOE, 1986b), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. CEARP was later succeeded by the Environmental Restoration (ER) Program. A number of sites that could potentially have adverse impacts on the environment

were identified. These sites were designated as solid waste management units (SWMUs) by Rockwell International (1987a). In accordance with the Rocky Flats Interagency Agreement (IAG), SWMUs are now designated as Individual Hazardous Substance Sites (IHSSs), which were divided into three categories:

1. Hazardous substance sites that will continue to operate and need a RCRA operating permit;
2. Hazardous substance sites that will be closed under RCRA interim status; and
3. Inactive substance sites that will be investigated and cleaned up under Section 3004(u) of RCRA or CERCLA.

The second major investigation completed at the plant in 1986 involved a hydrogeologic and hydrochemical characterization of the plant site. Plans for this study were presented by Rockwell International (1986c and 1986d), and study results were reported by Rockwell International (1986e). Investigation results identified areas considered to be significant contributors to environmental contamination.

### **3.1.3 Physical Setting**

RFP is located along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. The plant site is located on a broad, eastward-sloping pediment that is capped by alluvial deposits of Quaternary age (Rocky Flats Alluvium). The pediment surface has a fan-like form, with its apex and distal margins approximately two miles east of RFP. The tops of alluvial-covered pediments are nearly flat but slope gently eastward at 50 to 100 feet per mile (EG&G, 1991a). At RFP, the pediment surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys containing Rock Creek, North and South Walnut Creeks, and Woman Creek lie 200 to 250 feet below the level of the older pediment surface. These valleys are incised into the bedrock

underlying alluvial deposits, but most bedrock is concealed beneath colluvial material accumulated along the gentle valley slopes. The combined effects of stream-cut topographic relief and the shallow dip of the bedrock units beneath RFP suggests a potentially shallow depth to the Laramie formation in the valley bottoms.

### **3.2 SITE CHARACTERIZATION**

The Solar Evaporation Ponds (Solar Ponds) are located in the central portion of the RFP on the northeast side of the Protected Area (PA). The Solar Ponds Waste Management Unit, which is considered equivalent to IHSS 101, consists of five surface impoundments; Ponds 207-A, 207-B North, 207-B Center, 207-B South, and 207-C. IHSS 101 is located within the OU4 boundary. The area under investigation in this Phase I work plan includes the Solar Ponds and other areas and features which are considered pertinent to the characterization of OU4. The major features include the Solar Ponds, the Original Pond, the Interceptor Trench System (ITS) also known as the trench drain system, and areas in the immediate vicinity of the Solar Ponds.

#### **3.2.1 Regulatory History of OU4 Interim Response Actions**

The Solar Ponds were first identified as a RCRA regulated unit in the summer of 1986. Shortly thereafter, an interim status closure plan for the Solar Ponds was prepared in accordance with a compliance agreement. A closure plan for the interim status closure of the Solar Evaporation Ponds was required pursuant to Part 265 of the Colorado Hazardous Waste Regulations (6 CCR) and 40 Code of Federal Regulations (CFR), Part 265. This closure plan was revised in 1987 and again in 1988.

In late 1986, Phase I of a comprehensive program of site characterizations, remedial investigations, feasibility studies and remedial/corrective actions began at RFP. These investigations were initiated pursuant to the DOE CEARP and Compliance Agreement

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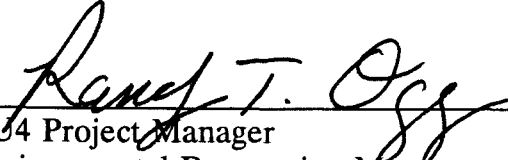
finalized by representatives of the DOE and the EPA on July 31, 1986. CEARP is now known as the ER Program. (EG&G Rocky Flats, 1991d).

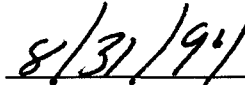
On June 28, 1989, DOE and the State of Colorado entered into the Agreement in Principle (AIP). This document states that certain contaminated sites (e.g., the solar ponds) at RFP require special and accelerated actions. The AIP specifies in part that DOE will expedite cleanup of the Solar Ponds in order to stem the flow of harmful contaminants into the ground water and soil.

On January 22, 1991, the DOE, EPA and the State of Colorado entered into a Federal Facility Agreement and Consent Order, commonly known as IAG. The IAG establishes the work and schedule for the RFI/RI and Corrective Measures Study/Feasibility Study (CMS/FS) response process. OU4 is currently in the Phase I RFI/RI stage. Phase I requires the characterization of sources and soils.

In accordance with the IAG and to fulfill the intent of the AIP, OU4 (the Solar Ponds) is presently in an Interim Measure/Interim Remedial Action (IM/IRA) process. The current IM/IRA is part of the enabling action taken to facilitate waste removal operations, cleanout of the ponds, and eventually site closure. Changes to the operation of the Solar Ponds are required to allow the dewatering of liquids and removal of sludges from the ponds. The IM/IRA proposes an alternate means of storing water collected by the ITS, and a means to treat these collected waters and excess liquids currently contained in the Solar Ponds. A summary of Solar Pond area history is provided in Appendix C.

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Date

#### 4.0 PROCESS OPERATIONS

Several operations will be performed throughout the OU4 site. They include the following:

- Site-Wide Radiological Survey and Surficial Sampling Program;
- Site-Wide Vadose Zone Monitoring;
- Field sampling and geophysical investigation in the vicinity of the Original pond;
- Field sampling and geophysical investigation of the existing Solar Ponds area; and
- Field sampling and investigation of the Interceptor Trench System (ITS) and site remainder.

These operations are detailed in the following sections.

##### 4.1 SITE-WIDE RADIATION SURVEY

A radiation survey will be performed throughout the entire OU4 site using either a high-purity germanium (HPGe) gamma-ray detector, if available, or Ludlum Model 12-1A radiation monitor with air proportional tube (or equivalent). However, use of the Ludlum Model 12-1A with the air proportional detector is not recommended. The characteristics of the instrument, the soil, and the alpha contamination in the soil does not lend itself to this type of survey. Problems associated with the use of this instrumentation include the fact that it is temperature and humidity dependent and that it damages easily. In addition, a

survey utilizing the Ludlum 12-1A would be difficult due to absorption of alpha particles in the soil and minimum depth penetration of alpha contamination from subsurface emitters. It is recommended that the site-wide radiation survey be done using the HPGe system. An additional possibility may be to use the FIDLER as an alternative instrument. Either a tripod-mounted or vehicle-mounted HPGe detector will be used, set up on either a 50 ft or 150 ft grid, respectively. If the HPGe system is not available, alpha and gamma/beta radiation readings will be taken at nearly 350 locations throughout the Solar Ponds area. Before radiation monitoring commences, survey points will be paced and/or taped off. Readings will be taken at each node of established grids in the ITS area, and in the Solar Ponds area. Additional survey points will be delineated in areas exhibiting a high count level of more than 250 counts per minute (cpm) if the Ludlum 12-1A monitor is used, or in elevated areas indicated by the HPGe. Once measurement locations have been selected, they will be surveyed with standard land surveying techniques. Data will be measured according to EG&G Standard Operating Procedure (SOP) Field Operations (FO) 16. Data must be recorded on EG&G Form FO.16A provided in Appendix D.

#### **4.2 SITE-WIDE SURFICIAL SOIL SAMPLING**

The appropriate number of surficial soil samples will be collected throughout the entire OU4 investigation site. Samples should be taken in areas where the Ludlum model 12-1A detects greater than 250 counts per minute (cpm). However, as stated above, the Ludlum 12-1A is not a recommended instrument and either the HPGe or FIDLER should be utilized. If a Ludlum 12-1A is used, the pull tape method must be incorporated into the survey strategy. An appropriate number of samples will also be obtained in random areas throughout the OU. As stipulated in SOP GT.8, two, 1 square meter (m<sup>2</sup>) areas located one meter apart will be established at each surficial soil location. Samples will be collected from the surface to a depth of one fourth inch in an area two inches wide by two and three fourth inches long using a Colorado Department of Health (CDH) sampler. Samples will then be



composited in a large stainless steel bowl or pan and stirred with a stainless steel scoop or spoon. Duplicate grab samples will also be collected in accordance with SOP GT.8 at ten to twenty percent of the sample locations. All sample handling procedures will follow SOP FO.13. Documentation of surficial soil samples will also follow SOP GT.8. Sample equipment decontamination between individual sampling points will follow SOP FO.13, General Equipment Decontamination.

#### **4.3 VADOSE ZONE MONITORING**

Vadose zone monitoring will be performed to characterize infiltration, vadose zone storage, and downward transmission of infiltration in response to precipitation events. Vadose zone monitoring will additionally correlate potential perched water horizons between the solar evaporation pond area and downslope seeps. Lastly, this type of monitoring will evaluate water recharge in the solar ponds. The vadose zone monitoring program is the subject of a technical memorandum currently in development.

Surface infiltration rates will be measured with a double ring infiltrometer. Data will be used to calculate a saturated hydraulic conductivity. A hydroprobe will be utilized to identify saturated horizons indicative of perched water conditions. These perched water horizons can be correlated between boreholes in an attempt to identify lateral migration pathways. A tensiometer can also be installed in high moisture zones to measure soil matrix potential.

#### **4.4 ORIGINAL POND**

Several activities including a document review, geophysical investigation, and unconsolidated materials investigation, will be performed for the area under investigation.

#### **4.4.1 Document Review**

A review of aerial photographs, engineering drawings, and historical information on the solar ponds will be performed to define original pond boundaries.

#### **4.4.2 Geophysical Evaluation**

A geophysical evaluation of the original ponds area will be performed to determine the original pond boundaries as well as the location of underground objects.

The geophysical evaluation will utilize ground penetrating radar (GPR) in accordance with SOP GT.18. This instrument is a source of electromagnetic radiation and uses electromagnetic pulse sources, a receiver antenna, and a graphic recorder to map reflections from subsurface interfaces caused by buried material. Antennas are available at frequencies of 80 megahertz (Mhz) to 900 Mhz. The GPR data is collected by slowly pulling the antenna across the ground's surface. A paper record is output by the graphic recorder during each traverse and is annotated in the field with traverse location, horizontal scale, full-scale time display and antenna used. Once anomalies are detected, the area must be staked off.

#### **4.4.3 Unconsolidated Material Investigation**

Unconsolidated materials will be investigated by drilling boreholes, collecting soil samples and performing chemical analyses. Boreholes will be drilled at pre-selected locations in the pond area. Soil cores will be collected in two foot increments as described in SOP GT.2. These cores will be screened while samples are being logged, using a radiation monitor and volatile organic compound detection instruments as described in SOP GT.1. Downhole geophysical borehole logging will be conducted according to SOP FO.18. After information is obtained, boreholes will be abandoned in accordance with SOP GT.5. All boreholes must be cleared in accordance with SOP GT.10. All drilling will utilize hollow stem augers and

boreholes will be installed using a truck mounted and/or skid or trailer mounted hollow stem auger drilling rig. Before proceeding to the next boring location, equipment will be decontaminated as in SOP FO.4. In addition, General Equipment Decontamination will follow SOP FO.4. Furthermore, all decontamination operations will follow SOP FO.12, Decontamination Facility Operations. All drilling and sampling procedures are outlined in SOP GT.2. Samples will be analyzed for metals, inorganics, radionuclides, volatile and semivolatile organic compounds, pesticides, and nitrate. Airborne contaminant dispersion will be minimized in accordance with SOP GT.1.

#### **4.5 EXISTING SOLAR PONDS**

In order to obtain information on the existing solar ponds, a review of facility engineering drawings and aerial photographs will be made. Other methods of characterization include a survey of pond liner cracks, a surface radiation survey as described in Section 4.1, geophysical survey as described in Section 4.4.2, and the drilling of boreholes to investigate unconsolidated materials.

In sites where a borehole will be installed, an air driven or electric powered jackhammer will be utilized to excavate the asphalt liner in an area of adequate size for sampling. Borehole construction and soil sample analysis will be conducted at select locations. Borings inside the ponds will be placed in cracks identified in the visual survey to determine if the cracks provided the primary pathways for contaminant migration. Borings inside the ponds will also be placed in areas where the current liner is in good condition to determine if cracks in the old liners provided additional pathways for contaminant migration. The liner and base will be removed at the borehole, and undisturbed materials below will be sampled. Proposed analyses include those listed above for the Original Pond soil samples.

#### **4.6 INTERCEPTOR TRENCH SYSTEM (ITS) AND REMAINDER OF SITE**

A radiation survey, surficial soil survey, and unconsolidated soil sample analysis will also be performed in the ITS and in areas away from the existing ponds throughout the site remainder. These procedures are described in Sections 4.1, 4.2, and 4.4.3, respectively. In addition, piezometers will also be installed.

Borehole construction and soil sample analysis will be conducted at the appropriate locations in the ITS and on the outer edges of the Solar Ponds area. Proposed borings will be advanced deeper than described in standard drilling and sampling collection procedures. These boreholes will be between 40 and 60 feet deep. Procedures for advancing these borings past the depth required for environmental sampling will follow SOP GT.4, Rotary Drilling and Rock Coring. Prior to the drilling of borings advancing into weathered bedrock, a surface casing will be installed according to SOP GT.3, Isolating Bedrock from the alluvium with Ground Surface Casing. The analytical parameter list includes metals, nitrate, inorganics, and radionuclides.

##### **4.6.1 Piezometer Installation**

Piezometers will be installed immediately upgradient and downgradient of the primary interceptor trench to provide information on water table configuration at the trench. Piezometer installation procedures will be in accordance with SOP GT.6. Water level measurements will be made in accordance with SOP GW.1 Once installed and preliminary effectiveness evaluated, tracer studies may be proposed to investigate potential, contaminated flow pathways.

#### **4.7 SAMPLE ANALYSIS**

All sample analyses will follow procedures stated in Section 4.2. All sample designation generated for the RFI/RI will conform to the input requirements of the Rocky Flats

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Environmental Database (RFEDs) as described in SOP FO.14A. Containers and preservation techniques will follow SOP FO.13. Information on preparing samples for radiological analysis must be in accordance with SOP FO.18. Sample control, identification and chain of custody must follow SOP FO.13. Field data must be managed as stipulated in SOP FO.2. Procedures for data quality control, verification, and entry into RFEDS, as well as archiving and security will follow SOP FO.14. Collection of quality control samples will be documented on the proper soil collection logs as stipulated in SOPs GT.2, GT.8, and GW.6. All samples to be sent off site must be packaged and sent in accordance with Health and Safety Practice 18.10. In addition, a property release evaluation will be generated.

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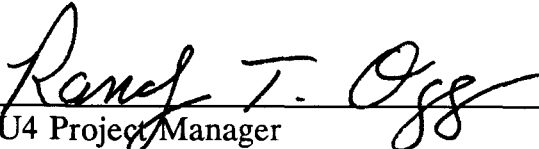
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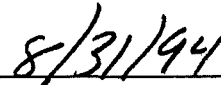
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## 5.0 CHEMICAL HAZARD CONTAMINATION AND ANALYSIS

### 5.1 INTRODUCTION

A summary of solar pond liquid sludge and soil analyses is provided in the Solar Evaporation Ponds Closure Plan (Rockwell 1988) as well as the Final Phase I RFI/RI Work Plan for the Solar Evaporation Ponds (U.S. DOE 1992). The Work Plan includes a summary of data from analyses performed by Roy F. Weston as well as data from the Rocky Flats Environmental Database (RFEDs). These data were utilized to assess the chemical and radiological hazards throughout the OU4 site. In addition, data from the Pond Sludge Waste Characterization Report (Haliburton, 1992) was also utilized in the hazard assessment. Data summaries taken from the Work Plan are provided in Appendix E.

In addition to soil, liquid, and sludge sample data available, air sampling in the breathing zone was performed in April 1990 by Occusafe, Inc. Samples were analyzed for total and respirable dust, metals, hydrogen cyanide, and organics. All results were below OSHA Permissible Exposure Limits (PELs).

### 5.2 CHEMICAL HAZARDS

The chemical hazards associated with OU4 site operations were assessed by reviewing the historical and current analytical results of liquid, sludge, and soil samples obtained throughout the site during the initial site investigation performed prior to liquid and sludge

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removal from the solar ponds. This information was compiled by Applied Environmental and incorporated into the RFI/FS workplan. These data were obtained for waste characterization purposes and provide an indication of the contaminants which may present a health risk during OU4 site activities. However, because these data were obtained for characterization purposes, they are not indicative of occupational exposures anticipated during site activities.

The major contaminants of concern at the OU4 site are heavy metals and radionuclides. Other compounds such as cyanide, hydrogen sulfide, phenol, and tetrachloroethene are also present onsite. These compounds are present in small concentrations and are not considered to be a significant hazard. However, since these compounds could probably become a hazard at higher concentrations, they will be monitored. All contaminants of concern are listed in Table 5.1 and in Sections 5.2.1 - 5.2.15. These compounds may be found in both air and soil and vary in their chemical, physical, and toxicological properties. Table 5.1 lists the compounds as well as their toxicity, volatility, skin absorption potential, carcinogenicity, exposure limits, and other pertinent information from a health and safety standpoint. This list is not inclusive of all chemicals which may be encountered at the OU4 site, but only those which have a greater frequency of detection, are present in the highest concentrations, and have the greatest potential for concern from a health and safety standpoint.

Toxicity indications are primarily based on acute effects. A compound's acute toxic effects are determined by the amount of chemical it takes to kill 50 percent of test animals ingesting the compound, over a short period of time. This chemical concentration is known as the Lethal Dose<sub>50</sub> (LD<sub>50</sub>). If the compound is administered through inhalation, the resulting chemical concentration which kills 50 percent of test animals is known as the Lethal Concentration<sub>50</sub> (LC<sub>50</sub>). In addition, available data on carcinogenic effects is

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TABLE 5.1  
TOXICOLOGICAL PROPERTIES FOR CONTAMINANTS OF CONCERN  
IDENTIFIED ON THE OU4 SITE

Compound <sup>a</sup>	CAS <sup>b</sup>	Volatility Rating <sup>c</sup>	Skin Absorption <sup>d</sup>	Carcinogen <sup>e</sup>	8-hr TWA <sup>f</sup> Exposure Limit (mg/m <sup>3</sup> ) <sup>g</sup>	Comments
Americium	NA	NA	No	Yes	NA	Bone-seeking, long-lived radioactive element. A confirmed human carcinogen.
Beryllium	7440-41-7	No	No	Yes	0.002	Poison by intravenous route. Effects by inhalation are lung fibrosis, dyspnea, weight loss. A confirmed human carcinogen.
Chromium	7440-47-3	No	No	Yes	0.5	Human poison by ingestion with gastrointestinal effects. A confirmed human carcinogen.
Plutonium	NA	NA	No	Yes	NA	Extremely poisonous. A confirmed human carcinogen.
Uranium	7440-61-1	NA	No	Yes	0.05	Highly toxic on acute basis. Causes kidney damage and arterial lesions. A confirmed human carcinogen.

<sup>a</sup> This list of compounds was obtained from past remedial investigations.

<sup>b</sup> CAS - Chemical Abstracts System number.

<sup>c</sup> Volatility Rating - based on vapor pressures at 20°C

A compound is considered volatile with vapor pressures greater than 5 mm of mercury (Hg).

<sup>d</sup> Skin absorption - "Yes" indicates that the compound has significant skin penetration based on ACGIH - 1991-1992 TLVs.

<sup>e</sup> Carcinogen - "Yes" indicates that the compound is a confirmed or suspected human carcinogen by the IARC, NIOSH, NTP, EPA, or ACGIH.

<sup>f</sup> 1991-1992 TLV - Threshold Limit Value of the ACGIH or OSHA Permissible Exposure Limit (Final Rule Limits), whichever is lower.

<sup>g</sup> mg/m<sup>3</sup> milligrams per cubic meter



presented to provide information for identifying chemicals which present the greatest potential for health risks.

The compounds found in highest concentrations at the OU4 site are metals and radionuclides with the primary route of exposure being inhalation. Inhalation hazards may be significant if particulate matter (dust) is not adequately controlled. However, based on the activities to be completed as well as appropriate administrative controls, engineering controls, and personal protective equipment (PPE) being utilized, it is believed that the overall chemical hazard is low.

Protective clothing and procedures described in Section 8.0 are designed to protect employees from chemical exposure via inhalation or dermal exposure. The potential for exposure depends primarily on the work activities and the care with which these procedures are performed. Any crew member will be removed from the work site if these initial symptoms persist:

- Dizziness or stupor;
- Nausea, headaches, or cramps;
- Irritation of the eyes, nose or throat;
- Euphoria;
- Chest pains and coughing; and
- Rashes or burns.

The majority of contaminants found in liquid, sludge, and soil throughout OU4 are not present in amounts great enough to create airborne exposures greater than the PEL. In addition, before RFI/RI activities commence in the solar ponds area, all sludge and liquid

will be removed from the ponds. This will greatly reduce airborne contaminant concentrations. However the contaminants of concern which may have airborne exposures close to the PEL will be characterized.

Sections 5.2.1.1 - 5.2.1.5 describe toxicity and symptoms of the major contaminants of concern at OU4. In addition, Sections 5.2.2.1 through 5.2.2.8 describe other contaminants onsite which will be monitored but are not anticipated to be a health risk. Tables 5.1 through 5.5 list the contaminants of concern and provide information on airborne concentrations. Lastly, Section 10.0 provides site-specific action levels.

### 5.2.1 Contaminants of Concern

#### 5.2.1.1 Americium

Americium is a silvery, malleable radioactive metal decay product of plutonium. It is a poison to humans and is stored in the bone. Long-term inhalation exposures can result in lung and bone tumors.

#### 5.2.1.2 Beryllium

Beryllium is a hard, brittle, gray-white metal with an 8-hour PEL-TWA of 0.002 mg/m<sup>3</sup>. Inhalation exposures to 0.1 mg/m<sup>3</sup> can produce pneumonitis. Chronic, long term exposure to beryllium can also produce tumors. There is a slight chance for beryllium concentrations under the pond liner to become airborne during drilling activities. Therefore, personal monitoring will be performed to determine airborne beryllium concentrations.

#### 5.2.1.3 Chromium

Chromium is a steel gray metal with a PEL-TWA of 0.5 mg/m<sup>3</sup>. Hexavalent chromium is a carcinogen. Exposures to airborne concentrations between 0.06 and 2.8 mg/m<sup>3</sup> can cause nasal irritation. Higher concentrations can cause skin dermatitis.

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**TABLE 5.2  
NON-RADIOACTIVE CONTAMINANTS OF CONCERN BY SPECIFIC OU4 SITES**

Location	Contaminant	Maximum Concentration (ppm) <sup>a</sup>		Maximum Airborne Dust Concentration <sup>b</sup> (mg/m <sup>3</sup> ) <sup>c</sup>	PEL-TWA <sup>d</sup> (mg/m <sup>3</sup> )
		Sludge	Soil		
Pond 207-A	Chromium Beryllium	19,700 1570	NA NA	5.0 1.27	0.1 0.002

<sup>a</sup> ppm - parts per million

<sup>b</sup> The dust concentration in milligrams per cubic meter (mg/m<sup>3</sup>) needed to exceed the eight hour permissible exposure limit (PEL).

(The respirable nuisance dust permissible exposure limit is 5 mg/m<sup>3</sup>. Therefore, all compounds represented in this column, except beryllium, would exceed the respirable dust PEL before exceeding the PEL for compound inhalation).

<sup>c</sup> mg/m<sup>3</sup> - milligrams per cubic meter

<sup>d</sup> PEL-TWA - Permissible Exposure Limit - Time Weighted Average

NA = Not analyzed

**NOTE:** Calculations utilized to determine maximum airborne dust concentrations are provided in Appendix F.

Sludge, soil, and liquid data are located in Appendix E.

**NOTE:** Solar pond data was taken from Dames & Moore (1991), Rockwell (1988), and Haliburton (1992). Data for areas surrounding the Solar Ponds was obtained through the Rocky Flats Environmental database.

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TABLE 5.3  
SLUDGE AND LIQUID pH IN THE SOLAR PONDS AREA

Location	pH	
	Liquid	Sludge
Pond 207-A	9.9	9.5
Pond 207-B North	8.5	7.3
Pond 207-B Central	9.1	9.2
Pond 207-B South	9.2	NA
Pond 207-C	10.2	NA

NA = Not analyzed

NOTE: Sludge and liquid data are located in Appendix E.

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**TABLE 5.4  
RADIOACTIVE CONTAMINANTS OF CONCERN**

Area	Isotope	Maximum Concentration		
		Liquid (pCi/l) <sup>a</sup>	Sludge (pCi/l) <sup>b</sup>	Soil (pCi/g)
Pond 207-A	Americium-241	200	4400 <sup>b</sup>	930
	Plutonium-239	660	3700 <sup>b</sup>	438
	Uranium-234	20,000	570 <sup>b</sup>	NA <sup>c</sup>
	Uranium-235	11	28 <sup>b</sup>	NA
	Uranium-238	28,000	480 <sup>b</sup>	NA
Pond 207-B North	Americium-241	0.14	ND <sup>f</sup>	NA
	Uranium-234	53	13	NA
	Uranium-235	1.7	0.40	NA
	Uranium-238	33	8.40	NA
	Plutonium-239	2.2	2.2	NA
Pond 207-B Central	Americium-241	5.5	ND	NA
	Plutonium-239	0.4	5.1	NA
	Uranium-234	780	70	NA
	Uranium-235	36	2.5	NA
	Uranium-238	900	75	NA
Pond 207-B South	Americium-241	0.1	2.4	NA
	Plutonium-239	0.1	1.9	NA
	Uranium-234	760	130	NA
	Uranium-235	31	2.9	NA
	Uranium-238	870	150	NA

**TABLE 5.4**  
**RADIOACTIVE CONTAMINANTS OF CONCERN**

Area	Isotope	Maximum Concentration		
		Liquid (pCi/l) <sup>a</sup>	Sludge (pCi/l) <sup>b</sup>	Soil (pCi/g)
Pond 207-C	Americium-241	13,000	1.7	NA
	Plutonium-239	2100	15	NA
	Uranium-234	2600	5.2	NA
	Uranium-235	120	0.8	NA
	Uranium-Total	40,000	ND	NA
	Uranium-238	3900	31	NA
Interceptor Trench Site	Plutonium-239	NA	NA	0.17
	Uranium-233/234	NA	NA	1.4
	Uranium-235	NA	NA	0.2
	Uranium-Total	NA	NA	2.8
East and South of Site	Plutonium-239	NA	NA	2.2
	Total Uranium	NA	NA	3.7
	Uranium-233/234	NA	NA	1.9
	Uranium 235	NA	NA	0.1
	Uranium 238	NA	NA	1.7
	Americium-241	NA	NA	0.61
Original Ponds Area	Plutonium-239	NA	NA	18
	Uranium-233/234	NA	NA	4
	Uranium-238	NA	NA	2.8
	Americium-241	NA	NA	2.2

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**TABLE 5.4  
RADIOACTIVE CONTAMINANTS OF CONCERN**

Area	Isotope	Maximum Concentration		
		Liquid (pCi/l) <sup>a</sup>	Sludge (pCi/l) <sup>b</sup>	Soil (pCi/g)
North and East of Pond 207-A	Plutonium-239	NA	NA	0.37
	Uranium-233/234	NA	NA	1.7
	Uranium-238	NA	NA	2.7
	Americium-241	NA	NA	1.2

- <sup>a</sup> pCi/l      picocuries per liter  
<sup>b</sup> pCi/g      picocuries per gram  
<sup>c</sup> M.A.C.    Maximum Expected Airborne Concentration  
<sup>d</sup> pCi/m<sup>3</sup>   picocuries per cubic meter  
<sup>e</sup> NA        Not Analyzed  
<sup>f</sup> ND        Not Detected

NOTE: Calculations utilized to determine maximum airborne concentrations are provided in Appendix F.

Maximum airborne concentrations were determined for the media with the highest specific activity after converting all data to values in pCi/g.

Sludge, soil, and liquid data are located in Appendix E.

TABLE 5.5  
MAXIMUM ALLOWABLE AIRBORNE DUST CONCENTRATIONS IN ORDER TO KEEP  
RADIONUCLIDE SPECIFIC ACTIVITY BELOW ONE TENTH OF THE DERIVED AIR CONCENTRATION

Area	Isotope	Maximum Concentration	One tenth of the Derived Air Concentration (DAC) (pCi/m <sup>3</sup> ) <sup>b</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for invasive procedures (mg/m <sup>3</sup> ) <sup>c</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for non-invasive procedures (mg/m <sup>3</sup> )
Pond 207-A	Americium-241	4400 <sup>a</sup>	0.2	0.002	0.05
	Plutonium-239	3700 <sup>a</sup>	0.6	0.005	0.16
	Uranium-234	570 <sup>a</sup>	2.0	0.117	3.5
	Uranium-235	28 <sup>a</sup>	2.0	2.4	71.4
	Uranium-238	480 <sup>a</sup>	2.0	0.139	4.2
Pond 207-B North	Americium-241	0.14 <sup>b</sup>	0.2	50,000	2,000,000
	Plutonium-239	2.2 <sup>b</sup>	0.6	10,000	1,000,000
	Uranium-234	53 <sup>b</sup>	2.0	1257	37,740
	Uranium-235	1.7 <sup>b</sup>	2.0	40,000	1,000,000
	Uranium-238	33 <sup>b</sup>	2.0	2020	60,606
Pond 207-B Central	Americium-241	5.5 <sup>b</sup>	0.2	1176	33,333
	Plutonium-239	5.1 <sup>b</sup>	0.6	4.0	120
	Uranium-234	780 <sup>b</sup>	2.0	85.5	2564



TABLE 5.5  
MAXIMUM ALLOWABLE AIRBORNE DUST CONCENTRATIONS IN ORDER TO KEEP  
RADIONUCLIDE SPECIFIC ACTIVITY BELOW ONE TENTH OF THE DERIVED AIR CONCENTRATION

Area	Isotope	Maximum Concentration	One tenth of the Derived Air Concentration (DAC) (pCi/m <sup>3</sup> ) <sup>b</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for invasive procedures (mg/m <sup>3</sup> ) <sup>c</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for non-invasive procedures (mg/m <sup>3</sup> )
Pond 207-B South	Uranium-235	36 <sup>b</sup>	2.0	55.6	1852
	Uranium-238	900 <sup>b</sup>	2.0	74	2222
	Americium-241	2.4 <sup>b</sup> pCi/l	0.2	2777	100,000
	Plutonium-239	1.9 <sup>b</sup> pCi/l	0.6	10,000	315,789
	Uranium-234	769 <sup>b</sup> pCi/l	2.0	87.72	2632
	Uranium-235	31 <sup>b</sup> pCi/l	2.0	2150	64,516
Pond 207-C	Uranium-238	870 <sup>b</sup> pCi/l	2.0	76.6	2299
	Americium-241	13,000 <sup>b</sup> pCi/l	0.2	3.9	117.6
	Plutonium-239	2100 <sup>b</sup> pCi/l	0.6	1.3	4.0
	Uranium-234	2600 <sup>b</sup> pCi/l	2.0	12.8	384.6
	Uranium-235	120 <sup>b</sup> pCi/l	2.0	83.3	2500
	Uranium-Total	40,000 <sup>b</sup> pCi/l	2.0	83.3	2500

TABLE 5.5  
MAXIMUM ALLOWABLE AIRBORNE DUST CONCENTRATIONS IN ORDER TO KEEP  
RADIONUCLIDE SPECIFIC ACTIVITY BELOW ONE TENTH OF THE DERIVED AIR CONCENTRATION

Area	Isotope	Maximum Concentration	One tenth of the Derived Air Concentration (DAC) (pCi/m <sup>3</sup> ) <sup>b</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for invasive procedures (mg/m <sup>3</sup> ) <sup>c</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for non-invasive procedures (mg/m <sup>3</sup> )
Interceptor Trench Site	Plutonium-239	0.17 <sup>a</sup>	0.2	39.2	1176.5
	Uranium-233/234	1.4 <sup>a</sup>	0.6	14.3	428.6
	Uranium-235	0.2 <sup>a</sup>	2.0	333	10,000
	Uranium-238	1.3 <sup>a</sup>	2.0	51.3	1538.5
	Uranium-Total	2.8 <sup>a</sup>	2.0	24.0	714.3
East and South of Site	Plutonium-239	2.2 <sup>a</sup>	0.6	9.0	272.7
	Americium-241	0.61 <sup>a</sup>	0.2	10.9	327.9
	Uranium-233/234	1.9 <sup>a</sup>	2.0	35.1	1052.6
	Uranium 235	0.1 <sup>a</sup>	2.0	666.7	20,000
	Uranium 238	1.7 <sup>a</sup>	2.0	39.2	1176.5
North and East of Pond 207-A	Uranium-Total	3.7 <sup>a</sup>	2.0	18.0	540.5
	Americium-241	1.2 <sup>a</sup>	0.2	5.6	166.7
	Plutonium-239	10.37 <sup>a</sup>	0.6	54.1	57.7
	Uranium-233/234	1.7 <sup>a</sup>	2.0	39.2	1176.5

TABLE 5.5  
 MAXIMUM ALLOWABLE AIRBORNE DUST CONCENTRATIONS IN ORDER TO KEEP  
 RADIONUCLIDE SPECIFIC ACTIVITY BELOW ONE TENTH OF THE DERIVED AIR CONCENTRATION

Area	Isotope	Maximum Concentration	One tenth of the Derived Air Concentration (DAC) (pCi/m <sup>3</sup> ) <sup>b</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for invasive procedures (mg/m <sup>3</sup> ) <sup>c</sup>	Maximum Dust Concentration in order to stay below one-tenth of the DAC for non-invasive procedures (mg/m <sup>3</sup> )
	Uranium-238	2.7 <sup>a</sup>	2.0	24.7	740.7
Original Pond Area	Plutonium-239	18 <sup>a</sup>	0.6	1.1	33.0
	Uranium-233/234	4 <sup>a</sup>	2.0	16.6	500.0
	Uranium-238	2.8 <sup>a</sup>	2.0	23.8	714.0
	Americium-241	2.2 <sup>a</sup>	0.2	3.0	90.0

<sup>a</sup> pCi/g    picoCuries per gram  
<sup>b</sup> pCi/m<sup>3</sup>    picoCuries per cubic meter  
<sup>c</sup> mg/m<sup>3</sup>    milligrams per cubic meter

NOTE: Calculations utilized to determine maximum dust concentrations are provided in Appendix F.  
 Sludge, soil, and liquid data are located in Appendix E.

#### 5.2.1.4 Plutonium

Plutonium is a silvery, radioactive metal which is chemically reactive. It is an extremely poisonous radioactive material. Plutonium differs from other heavy elements in regards to effects on bone surfaces. Plutonium directly affects bone surfaces rather than the more uniform bone distribution that other heavy elements display. Therefore, this increases the possibility of tissue damage resulting from plutonium exposure. Prolonged inhalation exposure to plutonium can produce lung and bone tumors. Americium, a plutonium decay product, is also found throughout OU4.

#### 5.2.1.5 Uranium

Uranium is a heavy, silver-white metallic metal. It is malleable, ductile, and softer than steel. Uranium is a highly toxic element and acute exposure may produce arterial lesions and kidney damage. Soluble uranium compounds can rapidly pass through the body which allows relatively large amounts to be absorbed. In addition, soluble uranium compounds may be readily absorbed through the skin. Insoluble uranium compounds have highly toxic effects due to lung irradiation from inhalation of particles.

### 5.2.2 Other Contaminants Found Onsite

Several contaminants are found onsite in low concentrations. These compounds are not expected to reach hazardous airborne levels. However, to verify concentrations, these compounds will be periodically sampled.

#### 5.2.2.1 Ammonia

Ammonia is a colorless gas, lighter than air, with an extremely pungent odor. This compound has an 8 hour PEL-TWA of 18 mg/m<sup>3</sup>. Exposures to concentrations between 50 and 100 ppm can produce skin, eye and respiratory tract irritation. The average concentration which most individuals can smell is 17 mg/m<sup>3</sup>.

#### 5.2.2.2 Arsenic

Arsenic is a brittle, silvery to black crystalline and amorphous metalloid with a vapor pressure of 1 mmHg. Arsenic is also a confirmed carcinogen and produces liver tumors. In addition, it is a poison by subcutaneous, intramuscular, and intraperitoneal routes. Arsenic has human systemic effects on the gastrointestinal (GI) system when ingested and it also effects the skin. Arsenic has an 8-hour PEL-TWA of 0.01 mg/m<sup>3</sup>.

#### 5.2.2.3 Cadmium

Cadmium is a blue-white malleable metal with a PEL-TWA of 0.05 mg/m<sup>3</sup>. Airborne exposures to 0.5 and 2.5 mg/m<sup>3</sup> have produced pneumonitis, mild cases of metal fume fever, and acute gastroenteritis. Concentrations of 50 mg/m<sup>3</sup> have caused death. Cadmium is also a known human carcinogen with experimental tumorigenic data.

#### 5.2.2.4 Cyanide

Cyanides compounds are white with a faint odor of bitter almonds. They have a PEL-TWA of 5 mg/m<sup>3</sup>. Exposures to airborne concentrations of 5 mg/m<sup>3</sup> can cause nosebleeds and nasal ulceration. Skin absorption of 50 to 100 milligrams (mg) can cause immediate collapse. Absorption of lower concentration may cause weakness, headache, confusion, nausea, and vomiting. Inhalation of 100 ppm of hydrogen cyanide gas can cause death. There is a small chance that some pond sludge and liquid migrated below the pond liner. This may cause the formation of hydrogen cyanide gas. The OSHA short term exposure limit (STEL) for hydrogen cyanide gas is 4.7 ppm. Since there is a slight potential for this gas onsite, detector tubes will be periodically utilized to determine hydrogen cyanide concentrations onsite.

#### 5.2.2.5 Hydrogen Sulfide Gas

Hydrogen sulfide is a colorless, flammable gas with an offensive "rotten egg" odor. The average concentration which can be smelled is 0.0094 ppm. It has a PEL-TWA of 14 mg/m<sup>3</sup> or 10 ppm. Exposure to airborne concentrations between 10 and 100 ppm can cause eye and mucous membrane irritation. Pulmonary edema and bronchial pneumonia can follow prolonged exposures to concentrations between 100 and 500 ppm. Concentrations between 500 and 1000 ppm can cause systemic poisoning, unconsciousness and death. There is a small chance that some pond sludge and liquid containing these sulfides migrated below the pond liner. This may cause the formation of hydrogen sulfide gas. Since there is a slight potential for this gas onsite, detector tubes will be periodically utilized to determine hydrogen sulfide concentrations onsite.

#### 5.2.2.6 Tetrachloroethene

Tetrachloroethene is a volatile colorless liquid with a chloroform-like odor. It has an 8 hour PEL-TWA of 339 mg/m<sup>3</sup>. Airborne exposures to 100 ppm causes slight eye irritation. Concentrations between 100 and 216 ppm cause lightheadedness, burning in the eyes, congestion of the frontal sinus, thickness of the tongue, and difficulty in motor coordination. High airborne concentrations greater than 2000 ppm can result in unconsciousness.

#### 5.2.2.7 Phenol

Phenol is a semi-volatile, white, crystalline mass, which turns pink or red if not perfectly pure. Phenol has a PEL-TWA of 19 mg/m<sup>3</sup> (5 ppm). Airborne concentrations of 48 ppm can cause irritation of the nose, throat, and eyes. Higher concentrations can also cause irritation to the eyes, skin, and mucous membranes. Phenol is an experimental carcinogen and teratogen.

#### 5.2.2.8 pH

Sludge and liquid stored within the Solar Ponds have pHs between 7.3 and 10.2. A pH of 7.0 is considered neutral. The higher a pH rises above 7.0, the more corrosive the compound or mixture will be. Corrosive mixtures can cause skin irritation, dermatitis, and burns. Table 5.3 lists the pH of sludge and liquid in the Solar Ponds.

### 5.3 EXPOSURE ROUTES

Although contaminants described in the previous sections can enter the body through inhalation, ingestion, absorption, and injection, the most common exposure route for RFI/RI activities will be inhalation of contaminants in dust which will be generated throughout the site. In order to prevent inhalation of contaminants, administrative and engineering controls will be implemented to reduce airborne dust concentrations. If administrative and engineering controls are ineffective, or not feasible, personal protective equipment such as respirators, will be utilized to further reduce dust concentrations. In order to assess the health risks associated with airborne contaminants, a calculation is used to extrapolate the Maximum Airborne Concentrations (MAC) which will expose the worker to the contaminant's PEL-TWA. This extrapolation procedure is described in Section 5.4.

### 5.4 MAXIMUM AIRBORNE CONCENTRATIONS (MAC)

Since the available site characterization data was sampled for waste characterization purposes, this data cannot be directly utilized to determine human exposures. However, the waste characterization data can be extrapolated to determine the amount of contamination which will become airborne. This extrapolation is performed by determining a maximum airborne dust concentration in milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ). This value determines the approximate amount of dust which a worker must inhale in order to exceed the OSHA PEL-TWA for a specific compound. When performing this calculation, a given compound concentration in parts per million (ppm) is divided by 1 million ppm. This calculation yields

the fraction of a specific compound in a given media. Next, the Permissible Exposure Limit (PEL) - Time Weighted Average (TWA) for the specific compound is divided by the fraction of the compound in the given media. This yields the MAC which a worker can inhale before exceeding the PEL-TWA for the specific compound.

$$\frac{\text{Compound Concentration (ppm)}}{1,000,000} = \text{The fraction of the compound in a given media}$$

$$\frac{\text{PEL-TWA for the compound in question}}{\text{The fraction of the compound in a given media}} = \text{The Maximum Airborne Dust Conc.}$$

A summary of non-radioactive contaminants of concern is presented in Table 5.3. This table provides the highest concentrations of the most toxic non-radioactive compounds present throughout the OU4 site. In addition, MACs are provided for each contaminant of concern. For a majority of the compounds in Table 5.3, the PEL-TWA for respirable nuisance dust of 5 mg/m<sup>3</sup> would be reached before workers would be exposed to the PEL-TWA of the contaminants of concern. The only contaminant which has a MAC less than the OSHA respirable nuisance dust standard of 5 mg/m<sup>3</sup> is beryllium with a MAC of 1.27 mg/m<sup>3</sup>. The MAC for beryllium is calculated as follows:

Given:

From Table 5.2 it is known that the maximum beryllium concentration in sludge is 1570 ppm.

From Table 5.2 it is also known that the PEL-TWA for beryllium is 0.002 mg/m<sup>3</sup>.



$$\frac{1570 \text{ ppm of beryllium in sludge}}{1,000,000} = 0.0016$$

$$\frac{0.002 \text{ mg/m}^3}{0.0016} = 1.25 \text{ mg/m}^3$$

Therefore, the Maximum Airborne Dust Concentration which workers can be exposed to without exceeding the PEL-TWA for beryllium is 1.25 mg/m<sup>3</sup>

The respirable nuisance PEL-TWA dust of 5 mg/m<sup>3</sup> is rarely reached during drilling activities. This is due to the fact that most of the soil brought to the surface while drilling is moist and therefore does not become airborne. In addition, engineering controls such as misting of dry soil will be implemented to reduce airborne dust concentrations. Therefore, it is highly unlikely that dust concentrations will reach high enough levels to require PPE for non-radioactive contaminants.

## **5.5 RADIONUCLIDE HAZARDS**

Workers may potentially be exposed to radionuclides during the RFI/RI. The risks from exposure vary according to the dose the worker receives, the type of radiation a worker is being exposed to, and the route of exposure.

The radionuclides of concern throughout the OU4 site include plutonium-239, americium-241, and uranium-233, 234, and 238. These radionuclides emit the majority of their radiation as alpha particles. Alpha particles do not penetrate the skin and are relatively harmless outside the body. However, once inhaled, these particles can cause internal damage. Relatively few beta particles and gamma photons are released. The beta and gamma radiations that are produced are of low energy. Beta particles can only penetrate the eye and outer layers of the skin and are also more of an internal hazard. Gamma

photons can penetrate the body and internal organs. Therefore, this type of radiation is an external hazard. However, gamma photon emission is not expected to be a hazard due to the low concentrations of contaminants.

### 5.5.1 Derived Air Concentrations

The hazard analysis of OU4 radionuclide contamination was completed by utilizing data presented in the Phase I RFI/RI Final Workplan (U.S. DOE, 1992) which was obtained between 1986 and 1991 for waste characterization. These data are located in Appendix E.

In order to extrapolate human exposure to radionuclides present at OU4, Maximum Estimated Airborne Concentrations (MAC) were determined for both invasive and non-invasive procedures. These levels were then compared to Derived Air Concentrations (DAC), which are airborne radionuclide specific concentration limits set up by the DOE to limit radionuclide exposure through inhalation. If MACs are above one tenth of the DAC for a specific nuclide, DOE requires the use of respiratory protection. Table 5.4 lists radionuclides found in several areas of OU4. In addition this table provides a maximum specific activity in liquid, sludge, and soil media and gives MACs and DACs for each radionuclide. Specific activities for each radionuclide were determined through laboratory analysis. Table 5.5 lists the maximum dust concentration allowed in order to stay below one tenth of the DAC. If work site dust concentrations exceed these levels, respiratory protection must be utilized. The formulas and calculations used to derive the MACs and DACs are described in Appendix F.

A mass loading approach has been utilized in determining the DAC for OU4. Formulas and calculations of DAC are described in the U.S EPA document number EPA 520/1-9-90-016, Transuranium Elements - Volume 2: Technical Basis for Remedial Actions, dated June 1990. Specific information on RFP is provided in Chapter 6, Radiological Assessment -

Rocky Flats Plant. Sections 6.1 - 6.2.8 which relate to mass loading calculations are included in Appendix F of this HASP.

In order to determine employee exposures during the RFI/RI, daily real time radiation monitoring as well as personal monitoring will be performed. These values will be compared with calculated maximum dust concentrations in order to stay below the DAC for invasive and non-invasive procedures.

The DOE has established DACs for specific radionuclides, that are the maximum levels which can be inhaled by workers. However, the DOE has established a policy requiring all radiation exposure to be reduced to levels "As Low As Reasonably Achievable" (ALARA). To reduce employee exposure to radionuclides during OU4 activities, administrative and engineering controls will be utilized to suppress airborne dust concentrations. If these controls cannot sufficiently reduce dust concentrations to a safe level, personal protective equipment will also be utilized.

#### **5.5.2 Site Conditions and Site Activities Which May Create Potential Radionuclide Exposures**

The potential for employee exposure to radionuclides depends on the following factors:

- Radioactivity levels of sludge and liquid present in the ponds, and the amount of airborne dispersion of radionuclides when RFI/RI activities commence;
- Radioactivity levels inside the ponds once they are cleaned out;
- Radioactivity levels of soils surrounding the ponds; and
- Radioactivity levels encountered when drilling activities are performed below the pond liner.

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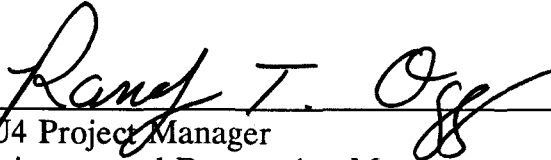
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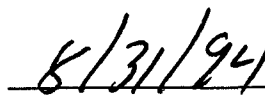
In addition, procedures performed during RFI/RI activities may also contribute to exposure to radionuclides. These procedures include the following:

- Drilling operations;
- Soil Sample collection;
- Decontamination of workers and equipment;
- Driving of vehicles and heavy equipment in radionuclide contaminated areas; and
- Maintenance and repair of process equipment.

As stated above, administrative, engineering, and personal protective equipment controls will be utilized to reduce airborne radionuclide concentrations, and exposures will be kept ALARA.

APPROVED BY:

  
OU4 Project Manager  
Environmental Restoration Management

  
Date

## 6.0 PHYSICAL HAZARD IDENTIFICATION AND ANALYSIS

In addition to the chemical hazards described in the preceding chapter, a variety of physical hazards may be present throughout OU4 during RFI/RI activities. These include temperature stresses, noise, adverse weather conditions, and mechanical hazards.

### 6.1 HEAT STRESS

In the spring, summer, and fall, temperatures in the Denver area can reach 100°F. A combination of these high temperatures, the use of personal protective equipment, and strenuous field work may result in heat stress.

Heat stress is caused by external heat sources such as high ambient air temperature and direct sunlight, or internal body heat build-up resulting from heavy work or prolonged use of such protective gear as encapsulating suits. Heat stress manifests itself in four disorders listed from most to least severe.

- Heat Stroke;
- Heat Exhaustion; and
- Heat Cramps.

These disorders and their symptoms are discussed below. Section 13.11.1 provides additional information on monitoring and prevention of heat stress disorders.

#### **6.1.1 Heat Stroke**

Heat stroke results from excessively high body temperatures which, in turn, disturb or interfere with the body's own heat regulating system. Normally, the body sweats, producing moisture for evaporation from the skin which is an effective cooling process. During heat stroke, this perspiration evaporation cooling process is interrupted, resulting in a rapid increase in internal body temperature.

Continuous exposure to high temperatures for as little as three hours can produce heat stroke. Symptoms of heat stroke may include any or all of the following:

- Body temperature extremely high, often 106°F and above;
- Red, hot and dry skin (sweating is absent);
- Pulse is rapid and strong;
- Possible convulsion or collapse; and
- Possible disorientation or unconsciousness.

If an individual has a body temperature of 104°F or higher, but is sweating, the individual is probably in a stage just before heat stroke. Therefore, this individual should be treated for heat stroke.

#### **6.1.2 Heat Exhaustion**

Heat exhaustion results from a failure of the circulatory system to compensate for the increased blood flow demands caused from dehydration, which in turn, results from profuse

sweating. Heat exhaustion can lead to heat stroke if it is not treated immediately. Symptoms of heat exhaustion may include any or all of the following:

- Slight elevated or reduced body temperature;
- Clammy and pale skin;
- Profuse sweating;
- Low blood pressure (pulse may be weak);
- Tired and weak;
- Dizziness or giddiness;
- Nausea or vomiting;
- Muscle cramps; and
- Fainting.

### 6.1.3 Heat Cramps

Heat cramps occur when working prolonged hours where profuse sweating takes place. Heat cramps can hinder work activities or cause a potential hazardous situation such as when working at high levels. Heat cramps are caused by a loss of salts resulting from sweating over a long period of time. Symptoms of heat cramps include painful muscle cramps and spasms; profuse sweating, vomiting, and/or convulsions; and normal, or near normal, pulse and blood pressure. Treatment for heat cramps includes resting in a shaded area, gentle massages to the affected areas, and drinking electrolyte fluids every 15 minutes for one hour if the individual is not vomiting. If the heat cramps are not relieved by giving fluids, and the symptoms continue, the individual should be taken to a medical facility. If an individual is on a low sodium diet or is taking diuretics, a physician should be consulted.

## **6.2 COLD STRESS**

In the fall, winter, and early spring temperatures in the Denver area can fall below freezing. A combination of low temperatures, wet clothing, and strenuous field work can result in cold stress.

Work activities conducted in cold weather can lead to severe health problems ranging from skin injury to loss of fingers or toes. Cold stress is caused by loss of body heat from radiation, conduction, convection, or evaporation. In addition, human factors that can contribute to cold stress include cardiac or respiratory conditions, fatigue, inadequate sleep, food, or water, and dehydration. Conditions of cold stress are discussed below. Workers must be able to recognize all signs and symptoms of cold stress on themselves as well as on their co-workers. Section 13.11.2 provides additional information on the monitoring and prevention of cold stress disorders.

### **6.2.1 Hypothermia**

Hypothermia is the progressive lowering of the body temperature and rapid mental and physical collapse. Hypothermia is the most serious of the cold stress disorders. Extended exposure to cold with aggravating circumstances such as moisture, wind, fatigue, inadequate clothing, and heavy perspiration with rapid cooling can play a major role in hypothermia. A personnel wearing wet clothes can develop hypothermia in temperatures as high as 50°F.

In the early stages of hypothermia, the body begins to lose heat faster than it can be produced. When the body can no longer generate enough heat to overcome the loss, the body temperature begins to drop. This effects the ability of the brain to make rational judgements and may result in loss of muscular control or consciousness. Hypothermia can result in death if not treated.



### **6.2.2 Frostbite**

Frostbite is the freezing of some part of the body due to exposure to very low temperatures. Frostbite usually affects the hands, feet, ears, and exposed areas of the face. There are three stages of frostbite based on the amount of skin damage. The three stages of frostbite are frostnip, superficial frostbite, and deep frostbite. Symptoms of each are discussed below.

Symptoms of frostnip include red skin which later becomes pale or waxy white, tingling, stinging, or coldness followed by numbness. Superficial frostbite results in the skin turning white or gray-white with a waxy appearance. In addition, the skin is firm to the touch and there is usually little or no feeling in the area. Deep frostbite results in the skin being pale, cold and solid to the touch, and all sensation is lost. Blisters and swelling follow thawing of parts.

## **6.3 WEATHER HAZARDS**

The primary weather hazards which occur at the RFP include lightning and high winds. These are described in the following sections.

### **6.3.1 Lightning**

Severe thunderstorms are common in Colorado in the spring, summer and fall. These thunderstorms often produce dangerous lightning which is a potential electrocution hazard. If a worker is struck by lightning, the shock can cause cardiac arrest, or death. The dangers associated with lightning increase when work is performed in flat open spaces, such as OU4, elevated work places, and on tall structures and equipment. In open areas, when working in elevated work places, or when working on or in water, all work will stop when thunder is heard or lightning strikes are sighted.

### **6.3.2 High Winds**

In the Denver area, high winds are possible throughout the year. High winds can cause contaminated water, sludge, and soil to become airborne and therefore increase the chance for worker overexposure to contaminants. Therefore, work will be restricted when sustained wind speeds reach 15 miles per hour (mph). If sustained wind speeds of 35 mph are measured, all outdoor work will stop. The EG&G meteorologist will determine wind speeds and maintain a liaison with the contractor's SSHO or designee to report adverse weather conditions.

### **6.3.3 Snowstorms**

Working in snow can create several types of hazards. Snow can create slippery conditions. This can, in turn, result in more slip and fall injuries. Working in cold, wet conditions produced by snowstorms can also lead to cold stress.

## **6.4 SUNBURN**

Sunburn can result in painful, red, swollen or blistered skin. Sunburn is usually a first-degree burn of the first layer of the skin (epidermis), and the effects may not be noticeable or felt for several hours after exposure. Treatment for sunburn includes the pouring of cool water on the affected area as quickly as possible and elevation of burned limbs. Ice or ice water can compromise bloodflow and cause further tissue damage. Advanced cases may require medical treatment.

## **6.5 BIOLOGICAL HAZARDS**

Biological Hazards throughout the OU4 site include bites from ticks, spiders, wasps, and rattlesnakes. An additional biological hazard includes contact with human blood and body fluids. This could occur during emergency first aid treatment. An example Bloodborne Pathogen Program is located in Section 15.0 of this HASP.

## **6.6 NOISE**

Noise is a potential hazard associated with operation of drill rigs. The hazards associated with excessive noise include workers being startled, annoyed, or distracted; physical damage to the ear; pain; temporary and/or permanent hearing loss; and communication interference that may increase potential hazards due to the inability to warn of danger and proper safety precautions.

Table 6.1 provides Threshold Limit Values (TLVs) for noise as published by the American Conference of Governmental Industrial Hygienists (ACGIH). OSHA also has published Noise Standards. However, noise guidelines published by the ACGIH are more conservative.

## **6.7 ERGONOMIC HAZARDS**

Ergonomic hazards associated with construction activities at the OU4 site include drilling, soil sampling, geophysical investigations, and vadose monitoring. These activities will subject workers to repetitive, forceful, and sometimes awkward movements and body positions.

## **6.8 UNDERGROUND UTILITIES AND PIPELINES**

EG&G will clear proposed borehole locations of all underground utilities prior to the contractor beginning invasive activities. Damaging underground utilities during invasive activities could lead to electric shock, explosion, exposure to toxic materials, and serious injury.

## **6.9 MECHANICAL HAZARDS**

Several types of mechanical hazards exist throughout the OU4 site. These hazards are associated with equipment utilized onsite, as well as with different work activities being

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FOR OPERABLE UNIT 4, SOLAR  
EVAPORATION PONDS  
ROCKY FLATS PLANT**

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**TABLE 6.1  
THRESHOLD LIMIT VALUES FOR NOISE**

<b>Duration Per Day Hours</b>	<b>Sound Level dBA*</b>
16	80
8	85
4	90
2	95
1	100
1/2	105
1/4	110
1/8	115**

\* Sound level in decibels are measured by a sound level meter, conforming as a minimum to the requirements of the American National Standards Specification for Sound Level Meters, S1.4 (1971 Type S2A, and set to use the A-weighted network with slow meter response).

\*\* No exposure to continuous or intermittent noise in excess of 115 dBA.

performed. Table 7.1 lists the hazards associated with work activities and equipment and provides safety measures to be implemented in each situation.

#### **6.10 VIBRATION**

A jackhammer will be utilized throughout the Solar Ponds area to break through the pond liners where boreholes will be drilled. Jackhammer use can cause excessive vibration. This vibration can lead to biomechanical diseases such as White Finger Disease.

#### **6.11 ELECTROMAGNETIC RADIATION**

Ground penetrating radar which will be used during the geophysical investigation, is a source of electromagnetic radiation. This type of radiation can also cause eye damage and has been linked to cancer.

#### **6.12 SLIPS, TRIPS, AND FALLS**

Obstacles such as heavy equipment, drill rigs, rocks, and vegetation can also cause slips, trips, and falls onsite. Only a minimum field crew should be in the vicinity of heavy equipment. In addition, the Solar Ponds area should be cleared of rocks and other obstacles before field work starts.

#### **6.13 HAZARD COMMUNICATION**

Several hazardous materials as defined by OSHA in 29 CFR 1910.1200 will be utilized and/or potentially encountered during the OU4 RFI/RI. In order to comply with the OSHA Hazard Communication standard, the SSHO will obtain Material Safety Data Sheets (MSDS) for all hazardous materials utilized during the course of the project. The MSDS will be kept onsite and made available to field team members upon their request. The hazards of these materials will be communicated along with other site hazards using site specific training and periodic safety briefings as necessary.

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MSDSs for all chemicals the contractor may be utilizing onsite are provided in Appendix J.

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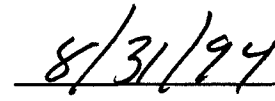
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## 7.0 HAZARD EVALUATION

Potential hazards which exist at the OU4 site were evaluated by reviewing the work plan and existing data regarding the liquid, sludge, and soil present onsite. In addition, physical hazards which may be encountered by field team members and subcontractor personnel during RFI/RI activities have also been evaluated. These hazards include chemical exposure from contaminated air and soils; physical hazards such as noise, weather conditions, heavy equipment, and motor vehicles; ergonomic hazards associated with drilling activities; and encounters with native wildlife. They shall be covered in site specific training and during daily safety briefings. The following briefly describes some of these anticipated hazards and guidelines.

Although the chemical hazards of acetone, tetrachloroethene, hydrogen sulfide, cyanide, and ammonia were described in Section 5.0, these compounds are only present in small quantities. Therefore, it is estimated that these chemicals will not be a hazard onsite. In addition to these chemical hazards, site-specific mechanical hazards briefly presented in Section 6.0 are summarized in Table 7.1. All data utilized to perform this hazard evaluation were obtained from the Solar Evaporation Ponds Closure Plan published by Rockwell International in 1988, A Summary of Chemical Analyses of Sludge and Water published by Dames & Moore in 1991, and the EG&G Rocky Flats Environmental Database (RFEDs).

## 7.1 SITE HAZARD SUMMARY

Pond sludge was analyzed for waste characterization purposes between 1986 and 1991. Sludge samples were analyzed for volatile organics, semi-volatile organics, anions, metals, and radionuclide specific activities. A limited amount of soil sample data exists. The vast majority of these samples are not of surficial soil. Soils were analyzed for metals and radionuclide specific activity. Characteristics of all contaminants of concern are described in Sections 5.0 - 5.2.17 and summarized in Tables 5.1 - 5.5. Hazards to be encountered in each site within OU4 are detailed below. Maps showing locations of the sites are provided in Figures 3-1 and 3-2. Site-specific action levels are also listed in Table 10.1.

### 7.1.1 Pond 207-A

Sludge and soils in Solar Evaporation Pond 207-A indicate maximum chromium and cadmium concentrations of 19,700 parts per million (ppm) and 10,500 ppm, respectively. Exposures to these metals above regulatory limits are not expected. However, 1570 ppm of beryllium in sludge have been measured in this area. If airborne dust concentrations exceed  $1.3 \text{ mg/m}^3$ , it is possible that beryllium levels will reach or exceed the PEL. In addition, data from soil samples indicate specific activities of americium-241 and plutonium-239 to be 930 picoCuries per gram (pCi/g) and 438 pCi/g, respectively. These radionuclides were also found in sludge with specific activities of 4400 and 3700 pCi/g, respectively. If soil dust concentrations rise above  $0.001 \text{ mg/m}^3$  in Pond 207-A, the MAC of these radionuclides will be exceeded. Because it is difficult to detect airborne dust at levels this low using real-time equipment, personal breathing zone samples will be obtained to document airborne radionuclide specific activities for determination of appropriate control procedures. Plutonium concentrations will be analyzed by either EPA Method 908.0, which is an isotopic analysis, or EPA Method 908.1, a fluorometric method. In addition, plutonium and americium will be analyzed by hydrofluoric acid and nitric acid digestion. In addition to inhalation hazards, the pond liquid is alkaline with a pH of 9.9. This may present a



**TABLE 7.1  
WORK ACTIVITY HAZARDS**

Work Activity	Equipment Utilized	Hazards Associated with Equipment and/or Work Activity	Safety Measures Implemented
Soil moisture content analysis	Hydro Probe	This device has a radioactive source	Employees using this device must receive proper training as required by the Colorado Department of Health (CDH)
Drilling Activities	Truck-mounted Hollow Stem Auger	The equipment and activities associated with drilling activities can cause back injuries. This equipment has rotating parts which create pinch points. There is also a possibility for inhalation of contaminants.	Workers must be properly trained in the use of truck-mounted augers. All rotating equipment must be properly guarded. Workers must also receive training as stipulated in Section 9.0. If dust is generated, engineering controls such as misting techniques will be implemented. If these procedures do not reduce airborne dust concentrations, respirators will be used.
	Rotating Auger	This type of equipment is loud and has the potential to injure feet and legs of the operator. It may also generate high dust concentrations. This equipment also has rotating parts which create pinch points.	Workers must wear steel-toed boots and avoid loose fitting clothing which can get caught in the equipment. Rotating equipment must be guarded. Sound levels will also be measured and if noise is greater than 85 dBA, ear plugs will be worn. If dust is generated, engineering controls such as misting techniques will be implemented. If these procedures do not reduce airborne dust concentrations, respirators will be used, and workers must also receive training stipulated in Section 9.0.
	Neutron Logs	This device has a radioactive americium beryllium source.	Employees utilizing this device must have proper training in its use.

**TABLE 7.1**  
**WORK ACTIVITY HAZARDS**

Work Activity	Equipment Utilized	Hazards Associated with Equipment and/or Work Activity	Safety Measures Implemented
Drilling Activities (continued)	Jackhammer	A jackhammer will be used periodically to break the asphalt liner before drilling. This device produces excessive vibration which can lead to peripheral neural disorders of the fingers and hands. In addition, it can also produce excessive noise and generate dust.	Employees using this device must have proper training. In addition, work gloves and metatarsal protection should be worn when using this device. Administrative controls, such as limited daily use time, should be implemented. Hearing protection should be used to minimize noise exposure and misting should be used to prevent airborne dust.
Well Completion	Silica sand, bentonite, and portland cement	Airborne dust will be generated when bentonite and silica sand are poured down the drill hole. Dust will also be generated during preparation of the portland cement.	Employees must have proper training in well completion. They should work at a slow pace in order to reduce the generation of high airborne dust concentrations. If this does not reduce dust concentrations, respirators will be worn.
Driving around the site, transporting drill rigs onsite, and transporting ground penetrating radar around the site.	Vehicles and Heavy Equipment	Slight potential for workers to be hit by moving vehicles. Dust will also be generated by moving vehicles and equipment.	If needed, orange traffic cones will be set-up throughout the site to direct traffic. Heavy equipment must have back-up warning devices. Only essential personnel will work in areas of heavy vehicle and machinery activity. If dust is generated, engineering controls, such as misting techniques, will be implemented. If these procedures do not reduce airborne dust concentrations, respirators will be used.

**TABLE 7.1  
WORK ACTIVITY HAZARDS**

Work Activity	Equipment Utilized	Hazards Associated with Equipment and/or Work Activity	Safety Measures Implemented
Operations and Maintenance	Hand Tools	Electrical hazards are associated with maintenance operations Cuts, punctures	Only qualified electricians are permitted to work on electrical equipment. Wear proper gloves to prevent hand injuries. Keep tools in good repair.
General Site Operations	Varies	Trips, falls, slips  Airborne debris and falling objects  Cold Stress  Heat Stress  Lightning and Wind	Good housekeeping procedures will be used to keep work area clean and free of obstacles. All workers must have training as stipulated in Section 9.0.  Hard hats, safety glasses, and steel-toed boots should be worn in areas specified by the SHSO. Work must be stopped when high wind warnings are issued.  Cold stress guidelines are stated in HASP. Proper clothing and personal protective equipment must be utilized to keep warm.  Heat stress guidelines are stated in the HASP. Proper clothing and personal protective equipment will be used to reduce sun exposure. Employees will be required to drink liquids during breaks.  If lightning is seen or thunder is heard, or a high wind warning is issued, the work site will be evacuated.

TABLE 7.1  
WORK ACTIVITY HAZARDS

Work Activity	Equipment Utilized	Hazards Associated with Equipment and/or Work Activity	Safety Measures Implemented
		Insect and snake bites	Use insect repellent, keep work area clear of vegetation. Workers will be warned if known rattlesnake areas exist on site.
		Ergonomic problems such as improper lifting can cause back injury.	Use two people to lift heavy loads. Use lifting aids such as hand-trucks. Lift with legs not back.
Geophysical Evaluation	Ground Penetrating Radar (GPR)	This unit will be pulled around the site by a truck and dust will be generated. This device is also a source of electromagnetic radiation.	Only essential personnel will work in areas of heavy vehicle and GPR activity. If it is feasible, engineering controls, such as dust, will be utilized to reduce airborne dust concentrations. GPR will be properly checked and calibrated by the manufacturer to prevent overexposures to electromagnetic radiation. Individuals utilizing GPR will be properly trained.

NOTE: The above hazards are specific for each activity and piece of equipment. All activities and pieces of equipment must also follow HASP regulations regarding daily inspections, proper equipment operation, personal protective equipment, air monitoring, decontamination, personal restrictions, employee training, heat and cold stress monitoring, and work/rest regimes.

hazard during drilling activities and may require the use of a Tyvex® coverall suit if liquid has migrated through the pond liner. It is anticipated that the liquids will be absent at that time.

#### **7.1.2 Pond 207-B North, Central, and South**

All three 207-B solar ponds indicate low levels of metals and radionuclides in sludge and soil. The highest radionuclide specific activity present in this area is 0.89 pCi/g for uranium-238. However, surficial soil samples have not been obtained in the vicinity of the 207-B ponds. Even if surficial soil samples do indicate low contaminant concentrations, caution should be observed due to possible windblown dispersion caused by the close proximity of the 207-B ponds to pond 207-A. If airborne dust concentrations rise above 0.25 mg/m<sup>3</sup> in air, airborne radionuclide concentrations will be near the MAC and respirators will be worn. However, engineering and administrative controls will be in effect in an attempt to maintain dust levels below 0.25 mg/m<sup>3</sup>. Liquid in Pond 207-B central is also alkaline with a pH of 9.1. This may require the use of a chemical protection suit during drilling and sampling activities if liquid is still present at the time of the field activities. It is anticipated that the liquids will be absent at that time. During invasive procedures performed in this area, breathing zone samples will also be obtained.

#### **7.1.3 Pond 207-C**

This pond exhibits specific activities of 13,000, 2,100, and 40,000 pCi/l for americium-241, plutonium-239, and total uranium present in the pond liquid. If airborne dust concentrations rise above 0.50 mg/m<sup>3</sup>, radionuclide concentrations will be near the MAC and respirators will be worn. Liquid in Pond 207-C is also alkaline with a pH of 10.2. This may require the use of a chemical protection suit during drilling and sampling activities if liquid is still present at the time of the field activities. It is anticipated that the liquids will be absent at that time.

#### 7.1.4 Interceptor Trench System

The ITS is located to the north of the solar ponds within OU4. Radionuclide specific activities and metal concentrations in the ITS are low. The highest specific activity in this area is 2.8 pCi/g for total uranium. If airborne dust concentrations exceed 5 mg/m<sup>3</sup>, respirators will be worn. However, administrative and engineering controls will be utilized to keep dust concentrations below 5 mg/m<sup>3</sup>.

#### 7.1.5 Original Pond Sites

Soil samples obtained in the area where the original ponds were located, indicate a maximum beryllium concentration of 7.9 ppm. In order to exceed the PEL for beryllium, airborne dust concentrations would have to exceed 253 mg/m<sup>3</sup>. Radionuclide concentration appears to be low in this area. The highest specific activity measured was 18 pCi/g for plutonium-239. If airborne dust concentrations rise above 0.50 mg/m<sup>3</sup>, radionuclide levels will approach the MAC and respirators will be worn.

#### 7.1.6 North and East of Pond 207-A

Radionuclide and metal concentrations are also low in the area. The highest specific activity for this site is 10.37 pCi/g for plutonium-259. If airborne concentrations reach 0.50 mg/m<sup>3</sup>, respirators must be worn.

#### 7.1.7 East and South of OU4

Soil samples to the east and south of OU4 indicate low contaminant levels. Radionuclide concentrations are also low in this area. Plutonium-239 is present in 2.2 pCi/g. If airborne dust concentrations exceed 0.5 mg/m<sup>3</sup>, respirators will be worn.

#### 7.1.8 Conclusion

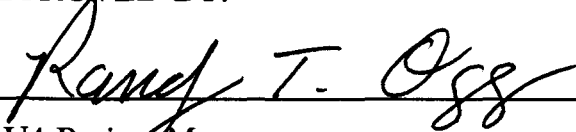
Ponds 207-A and 207-C have the potential to produce the highest chemical concentrations, pHs, and radionuclide specific activities during RFI/RI activities. In other locations throughout OU4, the respirable dust standard PEL of 5 mg/m<sup>3</sup> is expected to be reached before the PEL of the specific chemical hazards in question. However, due to the absence of data characterizing soils below the pond liners, unexpected hazards can be encountered anywhere, at anytime during RFI/RI activities. Therefore, breathing zone samples as well as other types of ongoing health and safety monitoring will be performed during the entire RFI/RI.

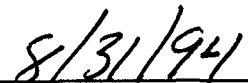
In addition to the chemical hazards present throughout OU4, mechanical dangers are also associated with RFI/RI activities and equipment. These hazards are listed in Table 7.1.

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## 8.0 EMPLOYEE EXPOSURE AND ENVIRONMENTAL MONITORING

Employee exposure and environmental monitoring will be conducted at the OU4 site for the following reasons:

- To assess the adequacy of required personal protective equipment;
- To avoid entrance to hazardous environments;
- To assess the need for medical assistance and testing for potentially exposed personnel;
- To assist in the determination of response actions in the event of an emergency;
- To assess the risk to the public and the environment due to potential offsite releases; and
- To record and provide employee exposure data in accordance with OSHA regulations.

Monitoring will be conducted using real-time instrumentation and personal sampling following procedures and methodologies recommended and required by either OSHA or NIOSH. Monitoring will consist of area sampling for various hazards, including volatile organics and particulates.



This section will detail requirements for monitoring, discuss levels of specific hazards, and provide actions to be taken at these levels. The section will also outline calibration requirements for various monitoring instrumentation. In addition, this section will describe appropriate quality control and documentation procedures, as well as recordkeeping requirements. Contaminants and corresponding monitoring equipment to be used by the contractor should also be included in this section.

### 8.1 MONITORING RESPONSIBILITIES

The HASP has set action levels and current monitoring requirements. If site conditions change or activities modified, the PHSM will develop new action levels and monitoring procedures including methods and frequencies. The SSHO will be responsible for conducting all monitoring and related tasks. The SSHO will be responsible for determining appropriate actions based on the results of real-time monitoring. All air monitoring results and data will be incorporated into the daily log of the SSHO.

### 8.2 REQUIRED MONITORING EQUIPMENT

Several types of monitoring equipment will be required to conduct necessary monitoring at the OU4 site. This equipment will include a real-time photoionization detector (PID); and a real-time aerosol monitor as well as personal sampling pumps and filter media.

If monitoring results indicate that levels of contaminants may exceed PEL's, integrated sampling equipment will be required as determined by the PHSM for personal exposure monitoring. The various types of monitoring equipment are discussed in subsequent sections.

### 8.3 REAL-TIME MONITORING

#### 8.3.1 Particulate/Aerosol Monitoring

Field team members will monitor particulate concentrations on a continuous basis during all dust generating activities. Monitoring will be completed with the use of a MiniRam real-time aerosol monitor. This instrument will measure aerosol concentrations over a range of 0.01 mg/m<sup>3</sup> to 100 mg/m<sup>3</sup>. The monitor also provides preferential response to the respirable size particulate of 0.1 to 10 microns ( $\mu$ m).

The monitor will be located where the area of highest exposure will be encountered as determined by the SSHO based on site observations and work activities. The MiniRam will be calibrated and maintained according to the manufacturer's recommended procedures. The SSHO will be responsible for maintaining and calibrating the instrument. Action levels for airborne dust concentrations are found in Table 10.1.

#### 8.3.2 Organic Vapor Monitoring

Although data indicates that organic vapors are not present onsite in hazardous concentrations, field team members will monitor organic vapors using a PID during site operations. The PID is sensitive to organics found at OU4. The SSHO or designate will monitor organic vapors at breathing zone height during RFI/RI activities.

Action levels for health, safety, and emergency response actions are listed in Table 10.1. Action levels are based on the relative response of the measuring instrument to the contaminants being monitored, Permissible Exposure Limit, and the protection factors of the respirators worn in each level of protection.

The PID will be calibrated daily according to the manufacturer's recommendations and guidelines. The SSHO or designee will calibrate the PID daily using isobutylene. In

addition, the SSHO will measure background levels of organic vapors daily at the support zone.

Responses to action levels will take place when organic vapor readings are sustained for more than 30 seconds and less than two minutes apart. When at least three readings of 30 seconds or more, less than two minutes apart from one to the other are recorded, appropriate responses will be taken.

### **8.3.3 Real-Time Monitoring Data Reporting and Documentation**

When organic vapor or particulate levels exceed background levels, the SSHO will report this information to the PHSM. The PHSM will then advise the SSHO as to when operations should cease, levels of protection upgraded, and/or emergency response/contingency plans initiated.

The SSHO will record all real-time air monitoring data on the log sheet as shown in Appendix G. This log sheet will be completed daily for each piece of real-time monitoring instrument used. Calibration data will be recorded on the Calibration Check Sheet located in Appendix G.

## **8.4 PERSONAL SAMPLING PUMPS**

Personal sampling pumps will be utilized in accordance with National Institute of Occupational Safety and Health (NIOSH) methods 7300, 0600, and 0500 to collect samples for inductively coupled plasma (ICP) metals, beryllium, chromium, respirable dust, and total dust. These methods are provided in Appendix L. Appendix H contains Personal Sampling Pump Calibration Sheets and Air Sample Data Sheets. Dust samples will then be analyzed for total dust, respirable dust, and radionuclide specific activity. Beryllium samples will be analyzed for total beryllium.

Personal samples will be obtained throughout OU4. Personal sampling pumps will be placed on personnel having the highest exposures as determined by the SSHO. Personal samples will be obtained during the first two or three days of invasive activities in each Solar Evaporation Pond. In addition, personal samples will also be taken during the first day of invasive activities outside of the Solar Evaporation Ponds. Personal sampling results will determine if levels of protection should be upgraded or downgraded.

#### 8.5 SMEAR/WIPE PAPER

Smear/wipe paper will be utilized to perform smear tests to verify that equipment meets DOE and EG&G radiological limits before leaving OU4. Guidelines for releasing equipment are presented in Table 11.3.

#### 8.6 LITMUS PAPER

Litmus paper will be utilized to monitor the pH of any liquid and/or saturated soils encountered during RFI/RI activities.

#### 8.7 HYDROGEN SULFIDE AND HYDROGEN CYANIDE DIRECT READING INSTRUMENTS

During drilling operations within the solar ponds, at least one employee working in worst case areas specified by the SSHO shall wear a direct reading instrument measuring hydrogen sulfide and hydrogen cyanide concentrations. This instrument must have an alarm which triggers when contaminant concentrations reach the PEL.

#### 8.8 DETECTOR TUBES

Ammonia concentrations throughout OU4 shall be measured utilizing a Sensidyne Detector Tube Pump with corresponding Detector Tubes.

## **8.9 SOUND LEVEL METERS**

A sound level meter will be utilized to determine employee noise exposures during all drilling and jackhammering activities. If sound levels rise above 85 decibels on the A scale (dBA), hearing protection must be utilized.

## **8.10 RADIONUCLIDE AIR MONITORING**

The maximum airborne dust concentration will be measured with the MiniRam respirable dust meter. The Maximum Expected Airborne Concentrations (MAC) of radionuclides in dust will then be extrapolated according to the calculations presented in Appendix E. Measured dust concentrations will then be compared to the lowest MACs as listed for each specific location in Table 5.6.

### **8.10.1 The Ludlum, Model 12-1A Radiation Detector**

A Ludlum, Model 12-1A Radiation Detector with Alpha Probe will be utilized to measure external alpha particle concentrations.

Acceptable airborne radionuclide particulate concentrations are based on DACs as described in Appendix F. Table 5.6 provides MACs and DACs for radionuclides present throughout OU4. The Ludlum Model 12-1A with a Model 44-9 Beta, and Gamma probe will be utilized to qualitatively measure all total surface contamination (fixed plus removable).

### **8.10.2 Thermoluminescent Dosimeters**

A Thermoluminescent Dosimeter (TLD) with a section for neutrons will be utilized to measure external dose equivalent exposures. These TLD badges will be replaced and analyzed by EG&G personnel once every three months. The TLDs must not be exposed to excessive heat or X-ray machines.

All instruments except the TLD must have been calibrated within the last 12 months and checked daily. Radionuclide air sampling methodology must be utilized at OU4. These specifications are described in Manual No. 3-21000-OPS-EMRG Environmental Management Radiological Guidelines Manual and in Rocky Flats Radiological Operating Instructions (ROI) 4.1.

#### 8.10.3 RAM-4 Radiation Monitor

The RAM-4 Radiation Monitor will be used to measure external fixed radiation.

#### 8.11 DECONTAMINATION MONITORING

All employees leaving the OU4 must have a whole body alpha frisk before leaving the site. If a frisk performed with a Ludlum Model 12-1A with an air propositional probe indicates levels greater than 250 counts per minute (cpm) per 100 square centimeters (cm<sup>2</sup>), the individual must undergo decontamination before leaving the site. In addition, if total alpha contamination is greater than 300 dpm per 500 cm<sup>2</sup>, the individual must undergo decontamination before leaving the site. The Environmental Health and Safety Specialist (EHSS) will perform this monitoring.

#### 8.12 SURFACE CONTAMINATION SURVEYS

The EHSS will also perform monitoring for surface contamination present on equipment utilized throughout the OU4, in the break trailer, storage areas, and changing rooms. The frequency of these surveys will be determined by the SSHO. Specific surface contamination monitoring procedures are classified in Environmental Management Radiological Guideline (EMRG) 3.1.

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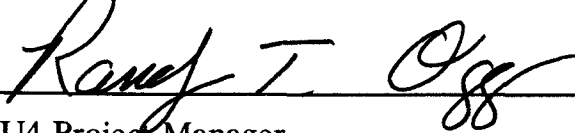
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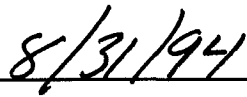
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## 9.0 EMPLOYEE TRAINING

### 9.1 GENERAL

Employee training programs for field activities at RFP will conform with the OSHA 29 CFR 1910.120, as well as EG&G, and DOE requirements. Any personnel working in or regularly entering the site (other than the support zone) for performing or supervising work, for health, safety, or administrative purposes, or for maintenance or any other site related purposes, must comply with the training requirements. Employee training requirements are given in Table 9.1.

### 9.2 40-HOUR H&S TRAINING

All field employees must have completed the 40-hour basic health and safety training required under OSHA 29 CFR 1910.120. In addition, all field employees shall be required to receive a minimum of 3 days of onsite training under the supervision of a trained and experience supervisor. This supervised field experience must be documented. In addition, this initial training must be updated annually with 8 hours of offsite training.

Individuals who have not completed required courses, or cannot show evidence of completing required training, will not be permitted to enter the site to perform hazardous

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**TABLE 9.1  
TRAINING REQUIREMENTS FOR EMPLOYEES WORKING AT OU4**

Operation Personnel	40-Hour Hazardous Waste Site Training	8-Hour Refresher Training	8-Hour Supervisor Training	Radiation Worker Training	Site Safety Briefings	EG&G General Employee Training	Bloodborne Pathogen Training	Respirator Fit Testing and Training	Hazard Communication
Routine or Occasional Site Worker	X	X		X	X	X	X	X	X
Routine or Occasional Site Worker (Support Zone)					X	X	X	X	X
Supervisors	X	X	X	X	X	X	X	X	X
Site Visitors (Level A or B PPE)	X	X			X			X	X
Site Visitor (Level C PPE)	X <sup>a</sup>	X			X			X	X
Site Visitor (Level D or No PPE)					X			X	X

<sup>a</sup> or 24-hour hazardous waste site training.



activities. The training requirements are intended to provide employees with the knowledge and skills necessary to perform hazardous waste site operations with minimal risk to their safety and health.

### **9.3 SUPERVISOR TRAINING**

All site supervisors must have completed an 8-hour training session for supervisors at hazardous waste sites, the basic 40-hour training course, and 3 days of onsite training. The supervisor training must address worker-on-the-job training, in addition to safety planning and legal aspects of managing hazardous waste site workers.

### **9.4 RADIATION WORKER TRAINING**

In addition to the training requirements discussed above, all field employees shall be required to receive the 8-hour EG&G sponsored Environmental Radiation Worker Training Class. This course is required by DOE Order 5480.11 and is used to educate employees about standard industry radiation protection procedures.

### **9.5 SITE SPECIFIC TRAINING**

All Project Team employees participating in EG&G RFP field activities shall also receive site specific training. The site specific training shall be conducted by the SSHO with assistance and/or consultation from the PHSM as necessary.

Prior to commencement of field activities, site specific training shall be conducted for all OU4 personnel, including subcontractors, working on the RFI/RI. The site specific training shall consist of an initial health and safety briefing on the following information:

- Names of personnel and alternates responsible for site safety and health;
- Safety, health, and other hazards present on the site;

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- Use of personal protective equipment, e.g., emergency escape respirator;
- Work practices by which the employee can minimize risks from hazards;
- Safe use of equipment on the site;
- Medical surveillance requirements including recognition of symptoms and signs which might indicate over-exposure to site hazards;
- Site control measures;
- Decontamination procedures; and
- Emergency response procedures for RFP.

Briefings will also be conducted for any OU4 employees participating in field activities at a later date. All health and safety briefings will be documented.

All field personnel must be provided with and read a copy of this HASP. At the end of the initial site specific training, attendants should sign a safety compliance agreement form, presented in Appendix A, stating that they have read, understand, and agree to comply with the provisions of the HASP. Individual's refusing to sign the form will not be permitted to work at the site.

## **9.6 DAILY SAFETY BRIEFINGS**

The SSHO or designee will conduct daily safety meetings prior to the day's field activities and document them in the project safety log book. A review of primary hazards related to site activities and modifications to safety and work procedures will be discussed. Daily weather reports will be reviewed and field personnel notified if temperature extremes or inclement weather could potentially threaten field personnel and activities. Work/rest regimes and other potential weather-related restrictions will be conveyed. After attending daily safety briefings, workers must sign the site safety briefing form located in Appendix I.

## **9.7      HAZARD COMMUNICATION**

According to 29 CFR 1910.120, hazardous waste operations must implement a hazard communication program meeting the requirement of 29 CFR 1910.1200. A copy of the contractor's hazard communication program will be retained in their main office.

The hazard communication program must apply to all field team members and subcontractor employees working throughout OU4. This program covers the hazards of chemicals which will be utilized throughout the OU4 site. In addition, training requirements as well as the use and limitations of MSDS are covered in this program.

### **9.7.1      Material Safety Data Sheets (MSDS)**

MSDS utilized by all field team members will contain information on physical characteristics, properties, routes of exposure, exposure limits, and symptoms of exposure for each hazardous material used for OU4 activities. The SSHO will keep a copy of all MSDS for compounds utilized throughout the OU4 site at the work site. These will be available for review by all employees, subcontractors, and site visitors. Most of the chemicals and radionuclides present on the OU4 site are waste products. Therefore, MSDS will not be supplied for these compounds. Sample field MSDSs are located in Appendix J.

### **9.7.2      Training**

Before working on the OU4 site, all employees will undergo site-specific Hazard Communication Training. This training will outline the specific hazards of chemicals utilized by employees during RFI/RI activities. Employees will also be informed of the hazards of waste products which are present throughout the OU4 site.

#### **9.8      TASK SPECIFIC TRAINING**

All contractor or subcontractor personnel involved in core logging activities must take the EG&G Core Logging Training Course.

#### **9.9      GENERAL EMPLOYMENT TRAINING**

All contractors and subcontractors working on OU4 activities must undergo one hour of General Employment Training (GET) in order to enter the OU4 site. This course covers Rocky Flats General Standard Operating Procedures (SOPs) relating to issues associated with working in a DOE facility.

#### **9.10     BLOODBORNE PATHOGEN TRAINING**

According to EG&G mandate, all field team members must have a bloodborne pathogen control program (BBPCP) in the event of exposure to body fluids when administering first aid procedures. This BBPCP requires that all employees who may potentially be exposed to bloodborne pathogens be trained on how to recognize activities which involve exposure to potentially infectious materials, as well as the use and limitations of PPE. An example of the contractor's BBPCP is provided in Section 15.0.

#### **9.11     RESPIRATOR FIT TESTING/TRAINING**

All employees working at OU4 must have been medically approved and fit tested for the use of a respirator. Employees must also be informed of respirator use, limitations, and upkeep.

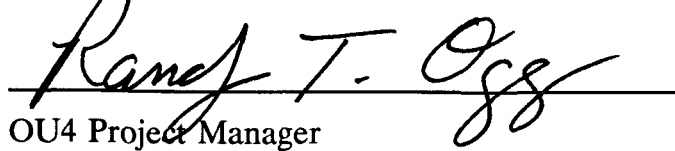
#### **9.12     DOCUMENTATION**

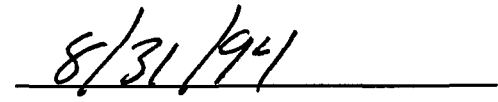
All training shall be certified with a training certificate or letter from the instructor. Copies of training completed by the contractor will be maintained by the PHSM and onsite by the SSHO.

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OU4 Project Manager  
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## 10.0 PERSONAL PROTECTIVE EQUIPMENT

The selection of personal protective equipment (PPE) for OU4 activities requires an evaluation of site specific contaminants and the concentrations and hazards that may be potentially encountered. The personal protective equipment and action levels established for project tasks are based on available data. As additional data and information become available, the PHSM will adjust personal protective equipment and action levels accordingly. Therefore, the personal protective equipment and action levels may change to provide the best possible protection and safety factors for contractor and subcontractor personnel participating in field activities.

### 10.1 UPGRADE AND DOWNGRADE

All contractor and subcontractor personnel participating in field activities may suggest to upgrade or downgrade the levels of protection due to additional hazards encountered or eliminated. The decision to downgrade will require consultation and approval of the SSHO, the PHSM, and the PM. Under no circumstances will the level of protection be downgraded without seeking consultation and permission beforehand. If protection is upgraded two levels higher than what is required by the HASP, the SSHO will immediately contact the PHSM prior to conducting the task. The SSHO must contact the EG&G Health and Safety Liaison Officer when changes are put in place for the upgrade and downgrade of personal

protective equipment. Action levels for upgrading and downgrading are provided in Tables 10.1 and 10.2 of this HASP.

## 10.2 LEVELS OF PROTECTION

Levels of protection have been defined in the EPA Standard Operating Guide, July 1988, and also in the OSHA regulation, 29 CFR 1910.120. The levels of protection currently anticipated for field activities include Level D, Modified Level D, and Level C. The following is a brief description of the degree of protection provided by each level which may be used during field activities. These levels are basic guidelines.

### 10.2.1 Level D

Level D is basically a work uniform. Level D protection provides no respiratory protection and minimal skin and eye protection. It is anticipated that work performed in the buffer zone will require Level D protection. This level of protection includes grey cotton coveralls, required by EG&G, leather, latex, or nitrile work gloves, a hard hat, safety glasses, work boots, and ear plugs in area with noise levels greater than 85 dB.

### 10.2.2 Modified Level D

Modified Level D includes the use of chemical protective suits for dermal protection, and is necessary for field activities that may result in contact with contaminated water and soil. A full-face air purifying respirator equipped with organic vapor or dust cartridges, as determined by airborne contaminant levels described in Section 5.0, should be readily available for immediate upgrade to Level C. Modified Level D protection requires the use of the EG&G required grey coveralls, and/or tyvek chemical-resistant coveralls. Latex inner gloves and nitrile outer gloves must also be worn. In addition, steel-toed safety boots with outer latex boot covers are required. Furthermore, safety glasses with side shields must also be worn. If noise levels exceed 85 dB, hearing protection must be utilized.

TABLE 10.1  
ACTION LEVELS FOR INVASIVE ACTIVITIES

Location	Compound Category	Action Levels	Estimated Personal Protective Equipment <sup>a</sup>
Pond 207-A	Dust (Radionuclides) <sup>b</sup>	<0.001 mg/m <sup>3</sup> <sup>c</sup>	No respirators required (Level D)
		0.001 - 5.0 mg/m <sup>3</sup>	Air purifying respirators with HEPA Cartridges (Level C).
	Volatile Organic Compounds	>5.0	Work will cease and dust control measures will be implemented
		<10 ppm <sup>d</sup>	No respirators required (Level D)
Ponds 207-B North, Central, and South and Pond 207-C	Dust (Radionuclides)	10 - 500 ppm	Air purifying respirator with organic vapor cartridges (Level C)
		>500 ppm	Exclusion zone will be evacuated until volatile organic compounds are specifically identified
	Volatile Organic Compounds	>10.0	Tyvek suit must be worn (Modified Level D)
		<0.35	No respirators required (Level D)
Ponds 207-B North, Central, and South and Pond 207-C	Dust (Radionuclides)	0.35 - 5.00	Air purifying respirators with HEPA cartridges (Level C)
		>5.00	Work will cease and dust control measures will be implemented
	Volatile Organic Compounds	<10 ppm	No respirators required (Level D)
		10 - 500 ppm	Air purifying respirator with organic vapor cartridges (Level C)

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**TABLE 10.1  
ACTION LEVELS FOR INVASIVE ACTIVITIES**

Location	Compound Category	Action Levels	Estimated Personal Protective Equipment <sup>a</sup>
	pH	>500 ppm  >10.0	Exclusion Zone will be evacuated until volatile organic compounds are identified  Tyvek Suit
Interceptor Trench Site, East and South of Site, North and East of Pond 207-A, and Original Pond Area	Dust (Radionuclides)	<1.00 mg/m <sup>3</sup>	No respirators required (Level D)
		1.0 - 10.0 mg/m <sup>3</sup>	Air purifying respirator with HEPA cartridges (Level C)
		>10 mg/m <sup>3</sup>	Work will cease and dust control measures will be implemented
		<10 ppm	No respirators required (Level D)
		10 - 500 ppm	Air purifying respirator with organic vapor cartridges (Level C).
	Soil and Liquid pH	>500 ppm  >10.0	Exclusion zone will be evacuated until volatile organic compounds are identified.  Tyvek Suit (Modified Level D)

<sup>a</sup> Personal Protective Equipment levels are determined according to data presented in Tables 5.2, 5.5, and 5.6.

<sup>b</sup> Specific personal protective equipment requirements are presented in Section 10.0.

<sup>c</sup> Radionuclide action levels are set by Maximum Expected Airborne Concentrations provided in Table 5.6.

<sup>d</sup> mg/m<sup>3</sup> milligrams per cubic meter

ppm parts per million



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**TABLE 10.2  
ACTION LEVELS FOR NON-INVASIVE ACTIVITIES**

Location	Compound Category	Action Levels	Estimated Personal Protective Equipment <sup>a</sup>
Pond 207-A	Dust (Radionuclides) <sup>b</sup>	<0.01 mg/m <sup>3c</sup>	No respiratory protection required (Level D)
		0.01 - 5.0 mg/m <sup>3</sup>	Air purifying respirators with HEPA Cartridges (Level C).
		> 5 mg/m <sup>3</sup>	Work will cease and dust control measures will be implemented
	Volatile Organic Compounds	< 10 ppm <sup>d</sup>	No respirators required (Level D)
		10 - 100 ppm	Air purifying respirator with organic vapor cartridges (Level C)
		> 100 ppm	Exclusion zone will be evacuated until volatile organic compounds are specifically identified
	Soil and/or Liquid pHs	> 10.0	Tyvek suit required
Pond 207-C	Dust (Radionuclides)	<3.0 mg/m <sup>3</sup>	No respiratory protection required (Level D)
		3.0 - 10 mg/m <sup>3</sup>	Air purifying respirator with HEPA cartridges (Level C)
		> 10 mg/m <sup>3</sup>	Work will cease and dust control measures will be implemented
	Volatile Organic Compounds	< 10 ppm	No respirators required (Level D)
		10 - 100 ppm	Air purifying respirator with organic vapor cartridges (Level C)
		> 100 ppm	Exclusion zone will be evacuated until volatile organic compounds are specifically identified
	Soil and/or Liquid pHs	> 10.0	Tyvek Suit

TABLE 10.2  
ACTION LEVELS FOR NON-INVASIVE ACTIVITIES

Location	Compound Category	Action Levels	Estimated Personal Protective Equipment <sup>a</sup>
Ponds 207-B North, Central, and South, Interceptor Trench Site, East and South of Site, and North and East of Pond 207-A	Dust (Radionuclides)	< 50 mg/m <sup>3</sup>	No respiratory protection required (Level D)
		5.0 - 10 mg/m <sup>3</sup>	Air purifying respirator with HEPA cartridges (Level C)
		> 10 mg/m <sup>3</sup>	Work will cease and dust control measures will be implemented
	Volatile Organic Compounds	< 10 ppm	No respirators required (Level D)
		10 - 100 ppm	Air purifying respirator with organic vapor cartridges (Level C).
		> 100 ppm	Exclusion zone will be evacuated until volatile organic compounds are specifically identified.
	Soil and Liquid pHs	> 10.0	Tyvek Suit (Modified Level D)

<sup>a</sup> Personal Protective Equipment levels are determined according to data presented in Tables 5.2, 5.5, and 5.6.

Specific personal protective equipment requirements are presented in Section 10.0.

<sup>b</sup> Radionuclide action levels are set by Maximum Expected Airborne Concentrations provided in Table 5.6.

<sup>c</sup> mg/m<sup>3</sup> milligrams per cubic meter

<sup>d</sup> ppm parts per million

### 10.2.3 Level C

Level C consists of the same protective clothing as in Modified Level D, with the addition of a full face air purifying respirator. While not anticipated, any upgrades to Level B (supplied air) will be done so upon recommendation by the PHSM or the SSHO. Upgrading PPE to Level B protection will require the use of airline respirators or self-contained breathing apparatus (SCBA).

## 10.3 EQUIPMENT FOR LEVEL D, MODIFIED LEVEL D, AND LEVEL C PROTECTION

The equipment required for the various field tasks is listed in Table 10.3. Adequate supplies of personal protective equipment will be available for all employees and at least two site visitors at all times.

## 10.4 RESPIRATORY PROTECTION PROGRAM

Respiratory protection will be selected, used, and maintained in accordance with OSHA 29 CFR 1910.134 and the contractor's Respiratory Protection Program. At this time, it is anticipated that negative pressure, full-face air purifying respirators with High Efficiency Particulate Absolute (HEPA) cartridges will be utilized as necessary during the OU4 RFI/RI. Respiratory protection requirements for contractor and subcontractor employees have been discussed above. Implementation of those requirements and those discussed below will be the responsibility of the SSHO with guidance from the PHSM.

### 10.4.1 Respiratory Selection

Initial required respiratory protection will consist of full face air purifying respirators equipped with high efficiency particulate air (HEPA) cartridges. Modifications to respiratory protection will be based on air monitoring data and field activities. All respiratory equipment will be jointly approved by NIOSH and the Mine Safety and Health Administration (MSHA).

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TABLE 10.3

PERSONAL PROTECTIVE EQUIPMENT FOR LEVEL D,  
MODIFIED LEVEL D, AND LEVEL C

Equipment	Material
<u>Level D</u>	
Work clothes (provided by employee)	Cotton (preferred)
Coveralls	Cotton
Work gloves (or nitrile if liquids present)	Leather or nitrile
Hard hat	
Safety glasses	Plastic
Work boots	Neoprene or leather with steel toe/shank
Ear plugs or muffs (in vicinity of heavy equipment)	
Face shield*	
<u>Modified Level D</u>	
Chemical resistant coveralls	Tyvek
Inner gloves	Latex
Outer gloves	Nitrile
Safety boots (inner)	Neoprene with steel toe/shank
Boot covers	Latex booties
Hard hat	
Safety glasses	Plastic
Face Shield*	
Ear plugs or muffs (in vicinity of heavy equipment)	
<u>Level C</u>	
Same as Modified Level D with addition of Full-Face Air Purifying Respirator with organic vapor cartridges or particulate (dust) cartridges or a combination of the two.	

\* As required by PHSM or SSHO

In the unlikely event that Level B is required, OSHA 29 CFR 1910.134 states that breathing air shall meet the requirement of the specification for Grade D or better breathing air as described in the Compressed Gas Association Specification G 7-1966. Contractors will require a Certificate of Analysis from vendors of breathing air in order to show that the air meets this standard.

Initially, respirators must be utilized according to action levels provided in Tables 10.1 and 10.2. Once personal samples are obtained and analyzed for specific activity, action levels may be changed.

#### **10.4.2 Respirator Availability**

Each individual on site requiring respiratory protection will be assigned a respirator in which the individual has been properly fitted. The individual will also receive a recloseable bag in which to properly store the respirator when it is not in use. Each individual receiving a respirator will place his/her name on the unit where it will not interfere with the seal and on the bag. Interchanging of respirators among workers will be strictly prohibited.

All cartridges will be changed a minimum of once every two weeks. However, water saturation of the filter or dusty conditions may necessitate more frequent changes. Changes will occur when personnel begin to experience increased inhalation resistance, or breakthrough of a chemical warning property. A sufficient quantity of cartridges will be available.

#### **10.4.3 Fit Testing**

Pre-project respirator fit tests will be required of all contractor personnel and subcontractors who may wear negative pressure respirators at OU4. The test will utilize isoamyl acetate and irritant smoke. The fit test must be for the style and size of the respirator to be used

by each employee. Additionally, a positive and negative fit check shall be conducted each time a respirator is donned.

#### **10.4.4 Medical Certification**

Only workers who have been certified by a physician as being physically capable of respirator usage will be issued a respirator. Those who have not or cannot show proof of certification will not be permitted to enter the exclusion or contamination reduction zones.

#### **10.4.5 Inspection, Cleaning, and Storing**

Respirators will be checked periodically by the SSHO and inspected before each use by the wearer. All respirator and associated equipment will be decontaminated and wiped cleaned after each use. Respirator wipes will be located at the Decontamination Pad. Upon cleaning, respirators will be thoroughly dried and placed into the supplied storage bag. The bagged respirator will then be stored when not in use in a location away from temperature extremes, sunlight, dirt, or hazardous chemicals which may degrade the integrity of the respirator. An inspection checklist is provided in Table 10.4.

#### **10.4.6 Miscellaneous Respirator Requirements**

Normal eyeglasses cannot be worn under a full-face respirator because the temple bars interfere with the respirator's sealing surfaces. For workers requiring corrective lenses, special spectacles designed for use with respirators will be provided. Only gas permeable contact lenses shall be worn with any type of respirator.

No personnel who have facial hair which interferes with the respirator's sealing surface will be permitted to wear a respirator. Personnel who report to work with interfering facial hair will be asked to shave prior to initiating daily activities. If the individual refuses, he will be dismissed from the site until he does report with interfering facial hair removed.

TABLE 10.4

PERSONAL PROTECTIVE EQUIPMENT  
INSPECTION CHECKLIST

Type of Personal Protective Equipment	Inspection
Chemical Protective Suit	Inspected for imperfect seams, tears, malfunctioning closures, discoloration, and stiffness
Gloves	Blow in new gloves to check for leaks, also check for tears and punctures
Air Purifying Respirators	Check respirator material for pliability, deterioration, and distortion;  Check face shields for cracks and fogging;  Check cartridges to make sure they are the proper type for intended use, that the expiration date has not passed, and that they have not been previously opened; and  Always perform positive and negative pressure checks before use.

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## **10.5      ACTION LEVELS FOR UPGRADING PROTECTIVE EQUIPMENT**

Action levels for upgrading personal protection and initiating emergency response actions are detailed in Tables 10.1 and 10.2.

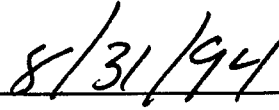


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OU4 Project Manager  
Environmental Restoration Management

  
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## 11.0 DECONTAMINATION AND PERSONAL HYGIENE

Decontamination and personal hygiene procedures will be the responsibility of the SSHO. All personnel will be trained in the specific steps for decontamination prior to entering the exclusion zone. The SSHO will inspect decontamination procedures and correct any deficiencies.

Decontamination procedures will take place at the new decontamination pad east of Pond 207-B North. The principal health hazards which could be associated with inadequate decontamination procedures at this pad include inhalation and skin exposure to beryllium and radionuclides. The following sections will discuss the proper decontamination procedures. Decontamination operations will comply with EG&G RFP EMD Manual Operation SOP, Manual 5-21000-OPS, Procedure Number FO.12, Rev. 2.

### 11.1 DECONTAMINATION

This section will outline decontamination procedures for personal and equipment, as well as cleaning of the decontamination area. In addition, disposal of generated wastes will also be addressed in this section.

#### 11.1.1 Personal Decontamination

All personnel leaving the Exclusion Zone (EZ) must be decontaminated using a soap and water wash solution, and a water rinse. Decontamination shall take place in the Contamination-Reduction Zone (CRZ) and is mandatory for all personnel exiting the EZ. The CRZ shall consist of the following:

- Fencing or some type of enclosure to prevent unauthorized traffic from entering the area;
- Step off pad and ancillary decontamination equipment;
- A separate exit and entry way to prevent cross contamination; and
- A sheet of plastic or polyethylene where decontamination equipment will located.

Workers leaving the EZ will remove all disposable PPE in the CRZ. All PPE will be removed prior to the removal of respirator equipment. The sequence for Level C decontamination is outlined in the following. Figures depicting Level D and Level C decontamination sequences should be provided as figures to this section.

- Place all equipment and supplies on plastic drop cloth provided;
- Remove hard hat and place in box next to plastic drop cloth;
- Remove all tape and place in waste container provided;
- Remove boot covers and place in waste container provided;
- Remove outer gloves and place in waste container provided;
- Remove disposable coveralls and place in waste container provided;
- Check for radiological contamination;
- Remove and wash respirator and place in storage bag provided; and

- Remove inner gloves and place in waste container provided.

Removal of PPE should be conducted in a manner to prevent skin contact with the outer portion of PPE.

The SSHO or designee(s) shall be responsible for assisting personnel leaving the EZ in decontamination procedures. Decontamination support personnel will assist in the following:

- Setting up wash stations for decontamination procedures;
- Setting up waste containers for disposal of PPE;
- Providing a plastic drop cloth for segregation of equipment needed to be decontaminated;
- Segregating of equipment on plastic drop cloth;
- Washing and rinsing off of personnel leaving the EZ;
- Removing and placing PPE in waste containers provided; and
- Bagging respirators.

Table 11.1 provides a list of equipment needed for decontamination of personnel and PPE. All decontamination procedures for handling of PPE will be conducted in accordance with EG&G RFP EMD Manual Operation SOP, Manual 5-21000-OPS, Procedure Number FO.6, Rev. 2.

#### **11.1.2 Equipment Decontamination**

Instruments or pieces of equipment that require decontamination will remain in the CRZ until they are adequately decontaminated and confirmed to be free of surface and internal radiological contamination ( $<20$  disintegrations per minute (dpm)/100 square centimeters

TABLE 11.1  
EQUIPMENT NEEDED FOR DECONTAMINATION  
OF PERSONNEL AND PERSONAL PROTECTIVE EQUIPMENT

Equipment	Use
Plastic Drop Cloths	Contaminated PPE and sampling equipment may be deposited
Waste Containers	Storing solid and liquid waste that must be discarded
Decontamination Solution (soap and water)	To remove contaminants
Long-Handled, Soft-Bristled Brush	Help wash and rinse off contaminants
Kim-Wipes	For wiping PPE
Radiation Monitor	Screen for radiation contamination
Organic Vapor Monitor	Screen for organic vapors
Lockers/Cabinets	Storage of decontamination clothing, equipment, supplies
Emergency Showers	Emergency Decontamination
Soap and Water Solution	To remove contaminants
Lockers/Closets	Storage of clean clothing and personal items

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(cm<sup>2</sup>) of removable alpha radioactive contamination), and visible residue. Decontamination procedures include the removal and disposal of plastic wrapping, and wiping down exposed surfaces using a cloth moistened with a soap and water solution. Table 11.2 provides a list of supplies needed for decontamination of equipment. Decontamination of general equipment will be conducted in accordance with EG&G RFP EMD Field Procedures SOP, Manual 5-21000-OPS, Procedure Number FO.3, Rev.2.

Large equipment, such as drill rigs, will be checked for radiation contamination, as needed, to meet radiological decontamination standards of 500/100 cm<sup>2</sup> total radioactive contamination (fixed plus removable). Once this is accomplished, the equipment will be steam cleaned and remonitored prior to being transferred from the Pad. Equipment leaving the CRZ will be monitored as outlined in Section 18.10 of the EG&G Health and Safety Practices Manual prior to removal from the CRZ. Decontamination of heavy equipment will be conducted in accordance with EG&G RFP EMD Manual Operation SOP, Manual 5-21000-OPS, Procedure FO.4, Rev 2.

Equipment will not be removed from the site until it has been determined that it has met the radiological contamination standards of <20 dpm/100 cm<sup>2</sup> of removable radioactive contamination, or 500 dpm/100 cm<sup>2</sup> total radioactive contamination (fixed plus removable). In addition, a Property Release Evaluation Form must be completed and approved by EG&G Radiological Engineering Department prior to removing the equipment offsite. Vehicles used in potentially radioactive areas will also be checked for radioactive contamination. This will be conducted prior to any vehicle leaving the RFP site. Radiation Control Limits are listed in Table 11.3.

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TABLE 11.2

EQUIPMENT NEEDED FOR DECONTAMINATION  
OF FIELD SUPPLIES, INSTRUMENTS, AND EQUIPMENT

EquipmentUse	
Plastic Drop Cloths	Contaminated equipment may be deposited and segregated
Waste Containers	Storing contaminated equipment that must be discarded
High Pressure Wash or Steam Cleaner	To remove contaminants
Kim-Wipes	For wiping equipment
Radiation Monitor	Screen for radiation contamination
Organic Vapor Detector	Screen for organic vapors

TABLE 11.3

RADIATION CONTAMINATION CONTROL LIMITS

TABLE I: ALPHA LIMITS			
Area	Removable		Total Fixed Plus Removable (dpm/100cm <sup>2</sup> )
	Smears (dpm/100cm <sup>2</sup> )	Swipes (dpm)	
Uncontrolled	20	N/A	500 <sup>(2)</sup>
Controlled	20	N/A	500 <sup>(2)</sup>
Radiological	200	500 <sup>(1)</sup>	5,000 <sup>(2)</sup>

TABLE II: BETA/GAMMA LIMITS		
Area	Removable Smear (dpm/100cm <sup>2</sup> )	Total Fixed Plus Removable (dpm/100cm <sup>2</sup> )
Uncontrolled	200	5,000 <sup>(3)</sup>
Controlled	200	5,000 <sup>(3)</sup>
Radiological	1,000	5,000 <sup>(3)</sup>

<sup>1</sup> Minimum detectable activity using the Ludlum Model 12-1A with air proportional detector. Total Efficiency (instrument and detector) is 50%. 250 cpm equals 500 dpm. No activity per area is specified since swipes are not used to quantify activity levels.

<sup>2</sup> 500 dpm/100cm<sup>2</sup> is the DOE limit for Uncontrolled and Controlled Areas. 5000 dpm/100 cm<sup>2</sup> is the DOE limit for Radiological areas. The minimum detectable activity using the Ludlum Model 12-1A with air proportional detector of approximately 50 cm<sup>2</sup> is 1000 dpm/100 cm<sup>2</sup> which corresponds to a 250 cpm instrument meter reading.

<sup>3</sup> 5000 dpm/100 cm<sup>2</sup> is the DOE limit for Uncontrolled and Controlled Areas and is the Rocky Flats limit for Radiological Areas. The minimum detectable activity (MDA) using the Ludlum Model 31 rate meter with the 44-9 pancake GM detector is 50000 dpm/1000 cm<sup>2</sup>. This corresponds to a meter reading of 200 cpm. The maximum allowed background for this MDA is 100 cpm with the instrument range switch on the X1 setting.

### 11.1.3 Samples Collected

Samples collected during field activities require a blanket property release evaluation and will be checked for radioactive contamination and decontaminated prior to removal from the site. Decontamination procedures include decontaminating containers using a soap and water solution. If samples test positive for radioactive contamination, they will not be permitted to leave the site. Samples shipped offsite must comply with applicable DOT regulations including 49 CFR part 107. Handling of residual samples will be conducted in accordance with EG&G RFP EMD Field Procedures SOP, Manual 5-21000-OPS, Procedure Number FO.9, Rev. 2.

### 11.1.4 Cleaning of the Decontamination Area (CRZ)

The CRZ will be kept clean and orderly by the SSHO and/or contractor in charge of the decontamination pad. The SSHO or his/her designee will ensure plastic bags or barrels are provided for the disposal of PPE, and adequate amounts of decontamination supplies are available. In addition, the SSHO or his/her designee will ensure the wash/rinse water is changed daily. Handling of decontamination water and wash water will be conducted in accordance with EG&G RFP EMD Manual Operation SOP, Manual 5-21000-OPS, Procedure Number FO.7, Rev.2.

### 11.1.5 Disposal of Generated Wastes

The waste liquid generated onsite will be stored and treated at the decontamination pad. All solid wastes generated (i.e., disposable PPE), will be contained in 55-gallon drums and left onsite until project completion. These drums must be labeled in accordance with applicable regulations.



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**11.2 PERSONAL HYGIENE**

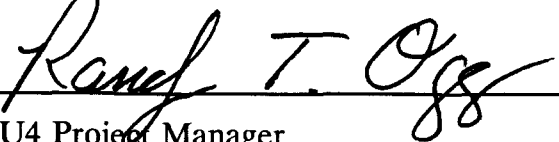
Personnel will be prohibited from smoking, chewing, eating, or drinking except in designated areas in the Support Zone (SZ). Personnel will be required to change in the provided changing facilities into EG&G issued coveralls, which will be removed by EG&G, and laundered by EG&G at the end of the day. Lockers will also be provided to store personal items. In addition, all employees working onsite must also take a shower in the Contractor shower facilities before leaving the plant.

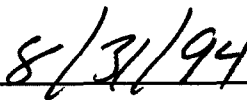
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OU4 Project Manager  
Environmental Restoration Management

  
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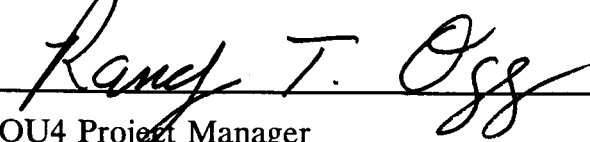
## 12.0 MATERIALS HANDLING

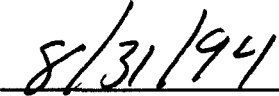
Several hazards may be associated with material handling activities. Operations which may create materials handling hazards include but are not limited to vehicle operation, drilling activities, loading, unloading and moving of equipment, use of hand tools, and utilization of electric motors. These materials handling activities can cause injuries such as cuts, lower back trauma, muscle sprains, broken bones, and electrocution. After more equipment design and construction information becomes available, more specific materials handling procedures will be outlined.

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### 13.0 ACCIDENT PREVENTION PLAN

This Accident Prevention Plan (APP) along with the rest of the HASP will be the accident prevention policy of the contractor and its subcontractors during work at the RFP. Details of the APP are presented below.

#### 13.1 PERSONNEL RESPONSIBILITIES

All contractor and subcontractor employees participating in RFP RFI/RI activities are expected to conduct themselves and their actions in a manner so as to minimize the potential for accidents. All field team members supervisory personnel will be responsible for seeing that individuals under their direct supervision are aware of the standard operating procedures for field activities and that they are carrying out the procedures in a safe manner. Variations in procedures or the addition of new procedures from this document must have the written approval of the PHSM prior to initiation. The SSHO will have day to day responsibility for enforcing this APP.

#### 13.2 EXPECTED SAFETY HAZARDS

Section 5.0 and 6.0 discusses the hazards anticipated during site work at RFP. In summary, these hazards include:

- Chemical - inhalation or skin contact with metals and radionuclides;

- Weather/Temperature Extremes - the weather can bring extreme heat, severe rainstorms, high winds, lightning, cold temperatures, and snow;
- Physical - including noise from heavy equipment, use of hand tools, motor vehicle operation, and hazards from the sun (ultraviolet radiation - sunburn); and
- Ergonomic - including heavy lifting and use of hand tools.

Overall, the hazards related to the RFP OU4 activities are low to moderate.

### 13.3 SUBCONTRACTOR SUPERVISION

All contractor and subcontractor personnel will comply with all provisions of the HASP. Subcontractor personnel will be required to attend all safety meetings and to read, review, and understand the provisions of the HASP dependent upon their assigned responsibilities. Each of the subcontractor personnel will be required to sign the acknowledgement form found in Appendix A of the HASP.

The subcontractor must provide proof that personnel meet the training, fit-testing, and medical surveillance requirements of the HASP if their activities will expose them to hazardous conditions. In addition, the subcontractor supervisory personnel must meet with the SSHO and the appropriate site task foreman daily to review activities for each day the subcontractor is onsite. A summary of this meeting will be logged in the SSHO field log.

The subcontractor will cease operations at any time if requested by the SSHO or the site task foreman. This request may be as a result of an observed safety violation, impending hazard not known to the subcontractor, or for any other reasonable cause known to the SSHO or the site task foreman.

#### 13.4 SAFETY MEETINGS

The SSHO will give a health and safety briefing prepared with the PHSM prior to initiation of field activities. This briefing will be of sufficient duration to address all of the material covered in this HASP. All contractor and subcontractor personnel that will be participating in field activities should have had the opportunity to read this HASP prior to this initial meeting so that any questions they have can be addressed at the initial meeting. Contractors will notify appropriate RFP representatives of this meeting so that they may review emergency and plant operating procedures with the employees.

Prior to commencing field activities each day, a short health and safety briefing will be conducted by the SSHO to address the day's activities as is necessary. The daily safety briefing will serve to notify individuals of any deficient areas that need to be corrected or operations changes made that affect field work. The briefing will emphasize the specific concerns associated with the day's planned field activities. Daily weather reports will be reviewed to determine work/rest regimen. The SSHO will complete the form shown in Appendix I following each meeting and retain the form as part of the project files.

#### 13.5 FIRE PREVENTION AND PROTECTION

To minimize the potential for fires, and to reduce the impact of any fire, proper fire prevention and protection procedures will be followed. The following list includes some of the most often cited fire prevention and fire protection requirements, but it is not intended to be all inclusive:

- No smoking is allowed in the exclusion zone or contamination reduction zone;
- All storage, handling, and use of flammable and/or combustible liquids, e.g., vehicle fuel, etc., must be under the supervision of the SSHO or a person designated by the SSHO and the requirements of OSHA's Hazardous

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Communication Standard (29 CFR 1910.1200) must be adhered to, e.g., training, Material Safety Data Sheets (MSDS) on site, etc.;

- Electrical lighting is the only means acceptable for artificial illumination where flammable liquids, vapors, fumes, dusts, or gases may be present. All electrical equipment and installations must be in accordance with the National Electric Code for Hazardous Areas;
- Portable fire extinguisher shall be provided where necessary (see below), inspected, and maintained in accordance with National Fire Protection Association Regulation #10, Portable Fire Extinguisher;
- An ABC fire extinguisher, rated not less than 10 lb shall be provided within 50 feet of an areas in which more than five gallons of flammable or combustible liquids or five pounds of flammable gas are being used;
- At least one portable fire extinguisher not less than 2-1/2 lb must be provided on all vehicles used for transporting or dispensing flammable or combustible liquids;
- Personnel will avoid driving and parking vehicles where tall vegetation may come in contact with hot tail pipes and catalytic converters;
- All spills of flammable and combustible liquids will be cleaned and containerized immediately; and
- Rubbish, rags, or other combustible material will be placed separately from areas where flammable or combustible liquids are stored, handled, or processed.

In the event of a fire or explosion, appropriate emergency responses will be followed, as presented in Section 14.0 of this HASP.

### **13.6 SITE HOUSEKEEPING**

The site will be kept in a neat, organized, and orderly fashion. Items such as tools, equipment, hoses, etc. will be kept picked up to minimize tripping and falling hazards. Used disposable clothing and equipment will be placed in drums immediately upon removal and

the drum lids replaced. Drums will not be filled to the point where the lid will not fit without force. Tall vegetation within a 10 ft radius of ignition sources, will be cut to a height of one inch or less.

The SSHO will inspect the site daily for housekeeping. These inspections will be recorded in a written fashion and maintained with the project log.

### 13.7 MECHANICAL EQUIPMENT INSPECTION

Inspection of mechanical equipment will be conducted as follows:

- Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent mechanic and certified to be in safe operating condition. Records of tests and inspections shall be maintained at the site by the contractor shall become part of the official project file, and shall be made available upon request of the designated authority;
- The SSHO shall designate an individual to be responsible for the inspection of all machinery and equipment daily and during use to make sure it is in safe operating condition. Tests shall be made at the beginning of each shift during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition;
- Preventive maintenance procedures recommended by the manufacturer shall be followed;
- Any machinery or equipment found by the contractor or designated authority to be unsafe shall be deadlined and its use prohibited until unsafe conditions have been corrected. A tag indicating that the equipment shall not be operated nor the tag removed shall be placed in a conspicuous location on the equipment. The tag shall remain until it is demonstrated to the individual deadlining the equipment that it is safe to operate. Where possible, lockout procedures shall be used;
- Inspections or determinations of road conditions and structures shall be made in advance to assure that clearances and load capacities are safe for the passage or placing of any machinery or equipment; and

- Other standard operating procedures as outlined in Section 18.0 will be followed.

### 13.8 FIRST AID AND MEDICAL FACILITIES

Initial first aid procedures will be conducted and evaluated by the SSHO or his designate. If the injury or situation cannot be handled with first aid, the SSHO will instruct personnel to call for emergency help as outlined in the emergency response procedures in Section 17.0. The SSHO, or his designate will be currently certified in multimedia first aid and CPR by the Red Cross or equivalent organization.

Complete first aid, medical information, and the type and location of emergency equipment can be found in Section 17.0 of the HASP.

### 13.9 SANITATION

Sanitation of the site will follow requirements of 29 CFR 1910.120(n). For the RFP, the following procedures will be implemented:

- There will be an adequate supply of potable water kept in clean, tightly closed containers with a tap. Containers used for distributing potable water will be marked. Where disposable cups are used, an appropriate receptacle will be nearby for proper disposal of the cups;
- All non-potable water sources will be clearly marked;
- Toilet facilities will be provided onsite. This facility will be equipped with a locking mechanism from inside. If the facility is portable, it will be serviced on a weekly basis;
- Shower and changing facilities will be cleaned on a daily basis and sanitized weekly. The facilities will be appropriately heated or cooled. They shall provide enough storage space for each worker to store and maintain street clothing and work clothing in a clean fashion. RFP currently has working



shower facilities in the contractor yard which can be used by the contractor's employees and subcontractors; and

- All individuals who enter the exclusion zone will be required to follow decontamination procedures as outlined in Section 11.0 of the HASP.

The following is a list of additional health and safety practices for health and safety concerns which have not been specified elsewhere in this HASP.

### **13.10 CONTAMINATION AND EXPOSURE PREVENTION**

Contractor and subcontractor personnel participating in field activities at RFP have the potential to become contaminated during the following activities:

- Contact with contaminated soils;
- Sitting or kneeling on the ground in the exclusion zone;
- Coming in contact with contaminated equipment; and
- Inhaling contaminated dusts.

Exposure to hazardous or contaminated materials shall be kept to a minimum by adherence to the recommended personal protective equipment and decontamination procedures. All Contractor and subcontractor personnel are expected to follow contamination avoidance work practices.

As much care as is feasible will be used to prevent contamination of small equipment. Sampling and monitoring instrumentation will not be set on potentially contaminated surfaces.

### **13.11 ONSITE MEDICAL MONITORING**

In addition to the provisions of the contractor's medical surveillance program, onsite medical monitoring of personnel should be performed for projects where heat stress or cold stress is a major concern. These are described below.

#### **13.11.1 Heat Stress Monitoring**

When activities at RFP take place during weather conditions where temperatures are above 70 degrees Fahrenheit (°F), heat stress symptoms will be monitored closely and a work/rest regime will be developed on a daily basis by the SSHO. The work/rest schedule will be dependent on weather conditions encountered. Physiological monitoring of deep body temperature and body water loss will not be feasible. Heart rate monitoring will be possible during break periods. During activities which do not require PPE, heat stress monitoring consistency of heart rate measurements will be initiated by the SSHO when temperatures reach 80°F during tasks considered light to moderate and 75°F during heavy work loads. During activities which do require PPE, the SSHO will initiate heart rate monitoring when temperatures reach 75°F for light to moderate work loads and 70°F for heavy work loads. A 10-minute break will be taken at these times to allow the SSHO to check heart rates. If individuals' heart rates are 110 beats per minute or less, they can resume work. If greater than 110 beats per minute, individuals will break another 10 minutes, and the next work period will be shortened by 33 percent. If the heart rate is still above 110 at the end of that 10-minute period, the individual will be decontaminated and rest in the support zone for at least one hour. These periods will be modified as employees become acclimatized to the heat.

To prevent heat-related illness, each site personnel will be required to drink at least eight (8) ounces of water or electrolyte-added drink at each break and at least 16 ounces at lunch. In addition, self-monitoring and buddy monitoring will be essential in order to prevent any

heat stress illness. If the dry bulb air temperature exceeds 70°F, the SSHO or designee shall monitor employees for any potential symptoms of heat stress or any unusual behavior. These measures, in addition to training on heat stress, should help prevent any heat stress illness from occurring. Section 6.1 provides information on heat stress disorders, how to identify symptoms of each, and emergency response actions.

If the air temperature remains below 70°F, the following work schedule is a guideline for all levels of protection listed in this HASP:

- 2 hours - work;
- 15 minutes - rest;
- 2 hours - work;
- 45 minutes - lunch;
- 2 hours - work;
- 15 minutes - rest; and
- 2 hours - work.

Rest means minimal physical activity. Rest should be accomplished in the shade. Any activity requiring only minimal physical activity can be performed during rest periods, e.g., preparation of sampling documentation, other paperwork requirements.

### **13.11.2 Cold Stress Monitoring**

When activities at RFP take place during weather conditions where temperatures are below freezing, cold stress symptoms will be monitored closely and a work/rest regime will be developed on a daily basis by the SSHO. The work/rest schedule will be dependent on

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weather conditions encountered. Physiological monitoring of deep body temperature will not be feasible. In cold weather, precautions should be taken to prevent cold exposure by wearing properly insulated garments and taking warm-up breaks when necessary. When temperatures are at or below freezing, provisions will be implemented for additional full body protection. In addition, workers will be warned not to allow even inadvertent contact of bare skin with items having a surface temperature below 19.5°F. For exposed skin, continuous exposure is not permitted for an equivalent chill temperature at or below 25.5°F.

To prevent cold-related illness, all site personnel will be required to drink plenty of fluids. In addition, self-monitoring and buddy monitoring will be essential in order to prevent any heat stress illness. Environmental monitoring using the air temperature and wind speed indices to determine wind chill will be conducted to determine work/rest schedules accordingly. If ambient air temperature is below freezing, the SSHO or designee shall watch employees for any potential symptoms of cold stress or any unusual behavior. These measures, in addition to training on cold stress, should help prevent any cold stress illness from occurring. Section 6.2 provides information on the types of cold stress disorders, how to identify symptoms of each, and emergency response actions.

If the air temperature remains above freezing, the following work schedule is a guideline for all levels of protection listed in this HASP:

- 2 hours - work;
- 15 minutes - rest;
- 2 hours - work;
- 45 minutes - lunch;
- 2 hours - work;

- 15 minutes - rest; and
- 2 hours - work.

Rest means minimal physical activity. Rest should be accomplished in heated areas. Any activity requiring only minimal physical activity can be performed during rest periods, e.g., preparation of sampling documentation, other paperwork requirements.

### **13.12 BUDDY SYSTEM**

Contractor and subcontractor personnel shall adhere to the buddy system when conducting field activities at RFP, meaning that they will work in groups of at least two when wearing personal protective equipment or when working in exclusion or decontamination areas. Prior to initiating activities in any exclusion area, field personnel will check in with the SSHO for clearance. Upon receiving clearance, field personnel may proceed with field activities.

### **13.13 ACCIDENT INVESTIGATION/REPORTING**

#### **13.13.1 Accident Reporting**

Reportable accidents include, but are not limited to:

- Injuries to personnel of any magnitude;
- Tool or equipment failure which results or could result in serious injury;
- Fire or explosion of any magnitude;
- Exposure of unprotected personnel to toxic agents;
- Vehicle accidents; and
- Any damage to client or private property.

All injuries/illnesses, no matter how minor they appear, are to be reported to the employee's immediate supervisor. The SSHO and supervisor should then see to it that the incident is logged and properly reported.

Under no circumstances will an injured employee drive himself/herself to the hospital, clinic, etc. An employee with minor injury may be transported by car after first aid treatment is given as decided by the SSHO. The employee who transports the injured person should be trained in first aid and CPR whenever possible. Any injury that is not minor, or when in doubt of severity of injury, will be transported by ambulance.

Employees who require medical treatment or are involved in incidents where the employee requires transport to a doctor, hospital, clinic, etc., will not be allowed to resume work without a written statement from the treating physician. This statement should give diagnosis, date of return to work, and any work limitations. Should a statement such as "light duty" be given, the SSHO will call the treating physician to determine the exact restriction that is needed.

### **13.13.2 Forms and Reporting Procedures**

#### **13.13.2.1 Injury/Illness Log**

An Injury/Illness Log will be kept at the OU4 site by the SSHO for injuries/illnesses and first aid treatment that is given to employees. All injuries, no matter how minor they appear, are to be logged. Minor injuries such as small cuts, scrapes, small first degree burns, and splinters that require only first aid treatment, are entered on this log only. Any incident that requires the completion of an Accident Report form must also be logged. Maintaining this log will help in meeting OSHA recordkeeping requirements and in responding to minor incidents before they become major. The original log should be retained in site records.

13.13.2.2 Accident Report

The contractor's Accident Report form located in Appendix K will be completed in the following work-related circumstances:

- Any work-related injury involving muscles and joints (sprains/strains);
- All work-related back injuries;
- All work-related chemical exposures;
- Any work-related injury/illness which involves medical treatment (treatment by doctor, hospital, clinic, chiropractor, dentist);
- Any work-related accident that results in death of an employee;
- Any incident that involves property damage or questionable property damage but not necessarily employee injury; and
- Any work-related incident (near miss) in which an injury could have occurred and that attention is needed to prevent similar incidents from occurring and preventing an injury accident.

Minor injuries such as scrapes, small cuts, small splinters that require first aid treatment only, do not require completion of the Accident Report. However, should condition of injury change and require medical treatment, then a report must be completed. If in doubt as to how to classify an injury (first aid or medical), complete the Accident Report. The Accident Report will be completed the day of the injury/accident.

The SSHO shall:

- Notify the contractor's main office, the PHSM, the consulting physician, and the RFP site representatives, by telephone as soon as possible;
- Complete the accident report within 24 hours of the occurrence;

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- Have involved employee(s) review and sign the report;
- Send original report to the contractor's main office within 24 hours;
- Retain a copy of the report for site records; and
- Fill out any written reports required by EG&G.

In the event an accident involves:

- fatal injury;
- five or more persons admitted to the hospital; or
- there is significant property damage (greater than \$50,000),

It will immediately be reported to the contractor's main office. This office will then conduct an in-depth investigation and the accident site should be left undisturbed if possible until released from the investigation. These situations will also be reported immediately to OSHA.

#### **13.14 SAFETY INSPECTIONS**

The SSHO will conduct and document daily safety inspections. These inspections will be recorded and maintained with the project files. All deficiencies noted during these inspections will be corrected as soon as possible depending upon seriousness of the deficiency.

#### **13.15 SAFE WORK PRACTICES**

Section 18.0 lists general work practices, standard operating procedures, and controls for the RFP site project. Following those general practices will assist in preventing accidents and exposures.



### **13.16 DUST CONTROL**

As a primary occupational health issue associated with this project relate to the inhalation of particulates, implementation of dust control measures will be an important control. A water spray or mist will be applied to the area in which grading, excavating, or compacting activities are being conducted. Only enough water should be applied to minimize dust emissions. If significant dust emissions cannot be prevented, the SSHO should be consulted regarding additional control measures, additional monitoring, or the use of personal protective equipment.

### **13.17 PHASE-ACTIVITY HAZARD ANALYSES AND CONTROL**

There will be numerous activities conducted by the contractor in various locations of the OU4 site which will expose field personnel to the hazards described above. These activities include, but are not limited to:

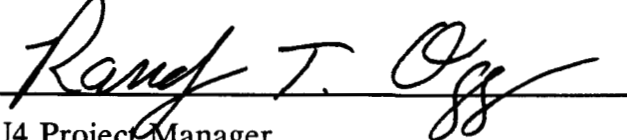
- Mechanized and manual soil excavation;
- Transport of contaminated soils;
- Soil sampling; and
- Use of vehicles and heavy equipment.

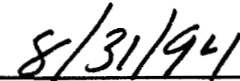
Tables 7.1 shows the hazards of the activities and the corresponding control procedures to be utilized at RFP. Many of the control procedures have been described elsewhere in the HASP. The tables will briefly describe control procedures and reference the appropriate sections of the HASP for a detailed explanation of the control mechanisms.

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#### 14.0 SITE CONTROL

Controlling the spread of contamination and unauthorized access to the site will be accomplished through the use of work zones, communication, and site security. Each of these will be detailed below.

##### 14.1 WORK ZONES

Prior to the commencement of RFI/RI activities at OU4, controlled zones of activity will be established as suggested by the NIOSH/OSHA/USCG/EPA's document titled "Occupational Safety and Health Guidance Manual for Hazardous Waste Activities." This will reduce the spread of any potentially contaminated material and reduce personnel exposure. The controlled zones will include the following:

- Exclusion Zone - where contamination does or could occur and where construction activities will take place;
- Contamination Reduction Zone - where decontamination operations will occur; and
- Support Zone - clean zone outside the contamination reduction zone.

Each work zone will be clearly identified on a site plan and/or delineated in the field with visible markings. This information must be communicated either verbally or through the use of diagrams to all contractor and subcontractor personnel.

#### **14.1.1 Exclusion Zone (EZ)**

An EZ will be established around each drilling area and around the location where the contaminated soils will be sampled and/or transported. In addition, a buffer area will be included in the EZ. The extent of the buffer area (i.e., 30 feet) and the exact location of each EZ will be based on site conditions and site entry points as determined by the SSHO. The exclusion zone will be posted with EG&G radiation work area signs and barriers will be used to demark the site entry points. A Radiation Work Permit (RWP) must be posted in accordance with the EMRGS. In addition, the RWP must be posted at all entry and exit points to the exclusion zone. At the present time, IHSS 101 is the Exclusion Zone. This will be modified as RFI/RI activities and conditions change.

All contractor and subcontractor personnel entering the exclusion zone must wear the prescribed levels of protection as outlined in Section 10.0. Levels of protection may change if conditions change or if more data becomes available. In addition, all field team members entering the exclusion zone must meet the medical surveillance and training outlined in Section 9.0 and 16.0. An additional egress location will be established prior to entering the exclusion zone in case an emergency egress route is necessary during the emergency. The status of each exclusion zone will change as RFI/RI activities proceed.

#### **14.1.2 Contamination Reduction Zone (CRZ)**

This area will minimize the transfer of contaminants from the exclusion zone to the support zone and offsite and prevents personnel exposure. The CRZ provides physical separation between the exclusion zone and the support zone, and provides transition from using clean

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to site-dedicated equipment. Personnel and equipment decontamination will occur in the CRZ. The CRZ shall be marked as such with visible markers.

It is recommended that the CRZ be established on the east side of the protected area (PA) near the decontamination pad east of Pond 207-B North. The protected area is where all plutonium operation at RFP are located. For work performed in the buffer zone, the CRZ will be set up near the buffer zone decontamination pad, or other suitable area as determined by the SSHO. The contractor shower and changing facility is also available for use and will be coordinated with RFP plant representatives. The SSHO, with guidance from the PHSM will be responsible for setup of a contamination reduction corridor (CRC). All liquids from personnel and equipment decontamination will be contained and discharged to existing sumps and treatment systems. To the extent feasible, small equipment taken into the exclusion zone shall be covered or bagged/contained in such a way as to allow for removal and disposal of the cover to provide decontamination. Heavy equipment such as drill rigs will be decontaminated using a high pressure, hot water washer or steam cleaner in the designated contamination reduction corridor.

#### **14.1.3 Support Zone**

The support zone shall be secured against active or passive contamination from the work site through distance from the EZ, physical separation by the CRZ, and decontamination procedures. The support zone will be established considering accessibility, current OU4 activities, wind direction, and line-of-sight to work. Included in this area will be the site office, vehicle parking, beverages for personnel, and a shaded break/lunch area. The support zone will serve as the communication base, and will be supplied with at least one outside telephone line. Location of some facilities within the support zone may change as conditions change.

## 14.2 SECURITY AND ACCESS CONTROLS

Site security will be the same as that presently in place for the site. However, contractor equipment and facilities will be locked at the end of each work day by the PM or his designee. Access to the site outside of work hours will be prohibited for contractor employees and subcontractors.

All visitors to the OU4 will be required to sign in and sign out, and a security log of all site access will be kept by the SSHO. Visitors will be briefed by the SSHO on health and safety procedures and will be escorted at all times on site. Visitors must be respirator fit-tested and trained in compliance with OSHA requirements to be allowed outside the support zone and into contaminated areas.

## 14.3 COMMUNICATIONS

EG&G will provide the contractor with a trailer equipped with hard-line telephone communications. Posted adjacent to the telephone will be emergency numbers, including:

- Plant security
- Plant fire department
- Plant ambulance;
- Plant medical building; and
- Plant emergency services.

In addition, the list of contacts shown in Section 17.0 will be posted.

EG&G supplied radios, as well as the EG&G public address system will be the primary methods of communication for employees involved in field activities.

#### 14.4 PERMITS

Activities throughout the OU4 site are controlled by the EG&G Radiation Work Permit. This permit describes job information, hazard descriptions, radiation safety requirements and permit duration. In order for the permit to be valid, approval signatures must be obtained before work commences.

In addition to the Radiation Work Permit, site activities are controlled by EG&G soil disturbance requirements such as an Excavation Permit. Further controls include contractor and EG&G SOPs as well as training requirements.

#### 14.5 RADIOLOGICALLY CONTROLLED AREA

OU4 is considered to be a Radiologically Controlled area (RCA) as well as a Radiological Area (RA). An RCA is designated when the contamination levels are below established standards, but radiological precautions may be necessary to alert workers of potential hazards. An RA is any area within an RCA with the following conditions:

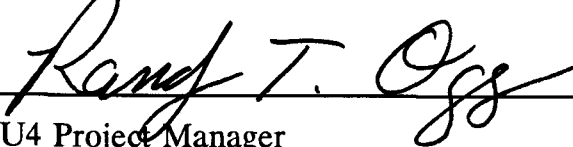
- Where an individual can receive a dose equivalent greater than 5 mrem in 1 hour at 30 centimeters (cm) from the radiation source or from any surface through which the radiation penetrates; and/or
- where airborne radioactive concentrations greater than one tenth of the derived air concentrations are present (or are likely to be); and/or
- where surface contamination levels exceed those specified in Table 11.3.

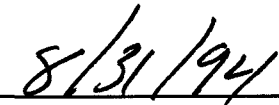
Due to the RCA and RA status of OU4, signs must be posted around the entire area.

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## **15.0 BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN**

Under EG&G directive, an example of the contractor's Bloodborne Pathogen Exposure Control Plan has been included in this HASP. This Bloodborne Pathogen Exposure Control Plan (BPECP) will be the bloodborne pathogen exposure prevention policy for all contractor and subcontractor employees who may come into contact with human blood or other human body fluids while working at RFP. Although all first aid procedures will be performed by EG&G personnel, this bloodborne pathogen control program will be followed in the unlikely event of contractor and subcontractor employee exposure to blood and body fluids.

### **15.1 PERSONNEL RESPONSIBILITIES**

The following subsections outline responsibilities of Project Team members, supervisors, the PHSM, and the SSHO.

#### **15.1.1 Onsite Personnel**

All personnel participating in RFI/RI field activities are required to participate in occupational exposure to bloodborne pathogens training. In addition, Project Team employees are expected to read and understand this BPECP, and conduct themselves and their actions in a manner so as to minimize the potential for exposure to bloodborne pathogens. Employees are also responsible for immediately notifying their supervisor of any exposure incidents.

### **15.1.2     Supervisors**

Supervisory personnel will be responsible for ensuring that individuals, under their direct supervision, are aware of the provisions set forth under this BPECP. These provisions include engineering and work practices, proper labeling requirements, PPE, and housekeeping. In addition, supervisors are responsible for ensuring their employees have received occupational exposure to bloodborne pathogens training. Supervisors are also responsible for reporting all exposure incidents to the SSHO or PHSM.

### **15.1.3     PHSM and SSHO**

The PHSM will be responsible for ensuring that all contractor employees have received training. In addition, the PHSM must maintain copies of training records, as well as medical records, and records of exposure incidents. The PHSM shall also maintain a list of tasks and procedures, or groups of closely related tasks and procedures in which occupational exposure to bloodborne pathogens could occur under certain, but rare, circumstances. Variations in procedures or addition of new procedure to this BPECP will also be the responsibility of the PHSM. Variations or new procedures will not be implemented without written approval from the PHSM. The SSHO will have day to day responsibility for enforcing this BPECP, and reporting exposure incidents to the PHSM.

## **15.2     ROUTES OF EXPOSURE**

Bloodborne pathogens may be present in body fluids such as blood and saliva, or in unfixed tissue. Bloodborne pathogens may enter the body through various means including, but not limited to, broken glass or sharp objects which can pierce or puncture the skin, such as nails, jagged edges on cans, or cutting utensils.



### **15.3 POTENTIALLY EXPOSED EMPLOYEES**

All RFI/RI employees have a slight chance of bloodborne pathogen exposure from injury of co-workers during OU4 activities. Personnel with the greater potential for exposure to body fluids as part of their job duties include the following:

- Occupational Health and Safety personnel;
- Emergency response personnel; and
- Employees trained in first aid.

### **15.4 ENGINEERING CONTROLS AND WORK PRACTICES**

Controls such as latex gloves and other PPE shall be used to eliminate or minimize employee exposure, where feasible.

Work practices shall be used to eliminate or minimize employee exposure, and shall include (but not be limited to) the following:

- No smoking, eating, or drinking in work areas;
- Food and drink shall not be stored where potentially infectious materials are present;
- Broken glassware or contaminated sharp objects shall not be picked up directly with the hands;
- Handwashing shall be enforced;
- Good housekeeping practices shall be enforced;
- Protective covering shall be used to protect equipment and other surfaces from contamination;

- Proper labeling in accordance with applicable regulations shall be used on potentially contaminated equipment or containers holding contaminated material; and
- Information on potentially contaminated equipment or material shall be conveyed to all affected employees.

### 15.5 PERSONAL PROTECTIVE EQUIPMENT

Employees must wear an apron and latex gloves if in contact with body fluids.

### 15.6 HEPATITIS B VACCINATION

All contractor and subcontractor employees who have the potential to be occupationally exposed to bloodborne pathogens, shall have available to them the Hepatitis B vaccine and vaccination series. The vaccination shall be provided free of charge to the employee through their employer. The Hepatitis B vaccination shall be provided in accordance with OSHA 29 CFR 1910.1030(f).

### 15.7 EXPOSURE INCIDENTS

Investigation of exposure incidents is required to determine the cause for the exposure and to prevent a recurrence. Investigation of the exposure incident will be conducted by PHSM or SSHO. In addition, the exposure incident and investigation will be documented and a copy will be provided to the exposed individual. A copy will also be kept on file in the contractor's main office.

Once an exposure incident is reported, a medical evaluation follow-up will be immediately available to the exposed individual. In addition, results of the individual's testing shall be made available to the employee. The employee shall be informed of applicable laws and regulations concerning disclosure of the identify and infectious status of the source individual.

#### **15.8 SPILL CLEAN-UP AND DECONTAMINATION**

Clean-up of blood and body fluid spills shall be performed by authorized personnel wearing the appropriate PPE. Surfaces or equipment potentially contaminated shall be immediately, or as soon as feasible, decontaminated. An approved germicide/sterilant will be used to decontaminate equipment or surfaces. Materials used in the decontamination process shall be placed in an appropriate labeled container. Under no circumstances will a RCRA regulated chemical be used as a germicide/sterilant.

#### **15.9 HANDLING AND DISPOSING OF POTENTIALLY INFECTIOUS WASTE**

Material that is potentially contaminated with infectious waste should not be handled without proper PPE. Potentially contaminated material should be placed in a proper container to minimize the spread of contaminants. Containers holding such material will be appropriately labeled in accordance with OSHA 29 CFR 1910.1030(g).

When moving containers of potentially contaminated material, the containers will be sealed tightly to prevent spillage or protrusion of contents during handling, storage, or transport. Containers should be placed in secondary containers if leaks occur. The secondary containers shall be closeable, designed to contain contents, and prevent leakage. In addition, these containers must be labeled or color-coded according to federal standards. Regulated wastes shall be placed in containers as addressed above.

Containers that are reusable shall not be opened, emptied, or cleaned manually in any manner that could potentially expose individuals.

#### **15.10 TRAINING REQUIREMENTS**

Employers will ensure that all employees involved in field activities at RFP participate in a training program. The training program shall provide information on the following:

- General explanation of epidemiology and symptoms of bloodborne diseases;
- Explanation of the employers control plan;
- How to recognize tasks and other activities that may involve exposure to potentially infectious materials;
- The use and limitations of methods that will prevent or reduce exposure including engineering controls, work practices, and PPE;
- Removal, handling, decontamination, and disposal of potentially contaminated equipment or material;
- Information on vaccinations and post-exposure evaluation;
- Emergency response action; and
- Labeling requirements.

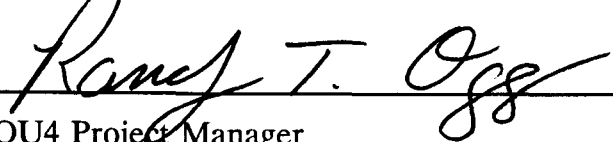
#### **15.11 RECORD-KEEPING**

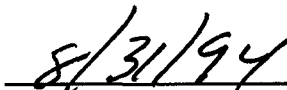
Training record shall be maintained for 3 years from the date on which training took place. Training records, as well as medical records, shall be readily available to the employee, to employee representative, to the OSHA Director, and Assistant Secretary in accordance with 29 CFR 1910.20.

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## **16.0 MEDICAL MONITORING**

### **16.1 MEDICAL EXAMINATION**

All contractor employees and subcontractors participating in field activities at RFP will be required to participate in the contractor's medical surveillance program, or an equivalent program that satisfies the OSHA standard 29 CFR 1910.120 (f). All medical examinations and procedures shall be performed by or under the supervision of an occupational physician. At a minimum, the medical examination will include the following elements:

- Occupational and medical history;
- Complete physical examination;
- Electrocardiogram;
- Pulmonary function test;
- Chest X-ray;
- Blood chemistry screening profile;
- Blood count with differential and platelets;
- Urinalysis;
- Vision screening;
- Audiogram; and

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- A baseline bioassay provided by EG&G.

The examining physician shall provide a written opinion on the examination which will contain the following:

- The results of the medical examination and tests;
- Opinion as to whether any detected medical conditions would place the employee at an increased risk;
- Physician's recommended limitation on assigned work; and
- Statement that physician has informed employee of results of examination and any medical conditions which require further examination or treatment.

All employees participating in field activities are subject to the contractor's and EG&G medical examination requirements. These include pre-employment and post-employment physicals, as well as yearly physicals. In addition, a medical examination must be performed if an employee has been acutely exposed to any chemical or physical hazards.

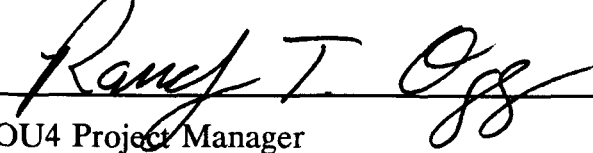
Content of the post exposure examination is highly dependent on the nature and extent of exposure. The need for a non-scheduled examination will be determined by the PSHM and the examining physician.

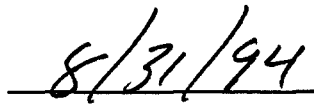
If requested by EG&G representatives, contractor employees and subcontractors may be required to submit urine and fecal samples for a radionuclide bioassay. This service will be provided by EG&G. Employees who have been exposed to radionuclides during previous activities may have to undergo additional testing procedures. After bioassays are performed, a Radiological Protection Incident Report Form RF-46988 and a Radiological Deficiency Report will be completed.

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## **17.0 EMERGENCY RESPONSE PLAN AND CONTINGENCY PROCEDURES**

This emergency response and contingency plan has been developed in anticipation of potential onsite and offsite emergencies during RFI/RI activities. The purpose of the plan is the provision of procedures and policies to minimize the impact of site-related emergencies. Emergencies which may occur during the RFI/RI include worker-related emergencies such as chemical exposure, accidents, medical problems, PPE failure, and physical injuries. Possible waste-related emergencies include fire, explosion, leaks, release of toxic vapors, and collapse of containers. This plan will outline the responsibilities and procedures for responding to these onsite emergencies.

### **17.1 PERSONNEL ROLES AND RESPONSIBILITIES**

All site personnel will have the responsibility of reporting all accidents and emergency situations to the SSHO immediately. Upon receiving information concerning site emergencies, the SSHO will activate emergency response procedures as outlined in this plan. Upon initial activation of the plan, the SSHO or his designee will immediately notify the Project Manager by telephone. Within 24 hours of notification, the SSHO will submit a written report to the contractor's main office. The written report shall include:

- Name and title of person reporting the incident;
- Date and time of incident;

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- Location of the incident;
- Brief summary of incident;
- Cause;
- Casualties (fatalities, disabling injuries);
- Details of any existing chemical hazard or contamination;
- Estimated property damage;
- Action taken by the contractor to ensure safety and security; and
- Other damage or injury sustained.

## **17.2      TRAINING**

The elements of this plan will be discussed in detail at the site-specific safety training course as discussed in Section 9.0. In addition, weekly and daily safety briefings and meetings will be utilized to review emergency procedures. Visitors will always be accompanied onsite by an individual who is knowledgeable in the site emergency procedures. In addition, site visitors will be briefed prior to entering the site on important emergency procedures, signals, and actions.

## **17.3      COMMUNICATIONS**

### **17.3.1      Onsite Communications**

Personnel crews onsite will be in visual and/or radio contact with support zone office and SSHO. Emergency information will be relayed through various mechanisms. However, because high noise levels may interfere with voice communication, secondary communications will be utilized whenever an emergency situation arises. These secondary communications will include a compressed air horn and hand and body signals. Compressed air horn signals will be utilized and signify the following:



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- One long blast - evacuate area immediately;
- Two short blasts - localized problem (not dangerous to workers); and
- Two long blasts - all clear.

Visual signals will include:

- Hands on head - need assistance;
- Thumbs up - all okay;
- Thumbs down - no; and
- Grip partners' waist with both hands - leave area immediately.

### **17.3.2 Offsite Communications**

The support zone office will be connected with telephone service for communication offsite. Next to each telephone will be a list of emergency telephone numbers and other vital information necessary for quick emergency response actions.

### **17.3.3 Alarms**

Although employees working on RFI/RI activities throughout OU4 will not be working inside buildings, they will be working in the PA near several buildings. Therefore, it is imperative that all employees become familiar with different types of RFP alarms. RFP has alarms for the following emergencies:

- Fire;
- Civil Defense;
- Civil Defense attack;

- Criticality;
- Glove Box Overheat; and
- Selective Alpha Air Monitor Alarm.

If an alarm is sounded, evacuate the area and proceed to the evacuation point stipulated by the SSHO. An announcement will come across the RFP life support/plant warning public address system with further instructions.

It is imperative that all employees learn the different alarm sounds. Therefore, before starting work at OU4, all employees must call 966-7541 and listen to a recorded message of the different RFP alarms.

#### **17.4      EMERGENCY RECOGNITION AND PREVENTION**

The elements of the HASP for the RFI/RI project will minimize the risk of an emergency situation occurring. However, regardless of how alert and careful site personnel are, unforeseen circumstances beyond the control of the field personnel can result in an emergency. It is important that field personnel are able to recognize when a situation occurs that is or may lead to an emergency situation.

In order to assist field personnel in recognizing these situations, daily safety briefings will be held which will be used as a forum to remind personnel of potential emergency situations and the procedures to follow in the event of an emergency. These meetings will review the tasks to be performed, the time constraints and work limitations for the day, hazards that may be encountered, and emergency procedures.

## **17.5      SAFE DISTANCES AND PLACES OF REFUGE**

### **17.5.1      Safe Distances**

EG&G and/or the SSHO will determine at the time of the emergency what a safe evacuation distance will be and alert all site personnel and visitors. This determination will be based on a number of factors including wind direction and speed; what the incident is; toxicological properties; and other specific incident and site-related factors.

### **17.5.2      Refuges**

A refuge will be established at the entrance to the contamination reduction zone. This refuge can be used for localized emergencies which do not require evacuation. This refuge will be a shaded area with emergency supplies.

## **17.6      ONSITE EMERGENCIES**

Field personnel will notify the SSHO immediately in the event of accident, injury, spill, fire, or other emergency or potential emergency situations. The SSHO will then activate the emergency response plan and follow appropriate actions. Various procedures are outlined below.

### **17.6.1      Site Security and Control**

The SSHO will locate and notify all field personnel and visitors in the event of an emergency. The SSHO will then ensure personnel are in safe areas as necessary and activate response procedures. The SSHO will ensure that all individuals responding to the emergency are appropriately equipped.

The SSHO will designate an individual to proceed to the site access gate and control the entry and exit of site personnel and visitors. Only EG&G emergency response personnel will be permitted to enter the site and the emergency area.

### **17.6.2     Evacuation**

All contractor employees, subcontractors, and visitors must evacuate the OU4 site under the following condition:

- If instructed by the Life Support/Plant Warning (LS/PW) Public Address System;
- If instructed by the Site Supervisor; and
- When the wind speed reaches 35 miles per hour (mph).

Personnel will be directed to evacuate an area in the event of a high wind or lightning warning.

On a daily basis, the SSHO will designate two safe evacuation areas. If evacuation is necessary from an area, the upwind safe area will be used as a gathering place where the SSHO or his designate can account for all site personnel and visitors. At this time, further instructions will be provided to evacuees.

### **17.6.3     EG&G Notification**

EG&G notification requirements are based on the type and seriousness of the situation. If a spill or other non-life threatening situation occurs, the Project Manager, Bruce Peterman, must be notified at extension 8659 (pager 5472). In addition, the Health and Safety Liaison Officer, Lisa LeLievre, must also be notified at extension 7691 (pager 5390). If the above personnel cannot be contacted, Rocky Flats Emergency response personnel must be directly notified.

#### **17.6.4 Life Threatening Emergencies**

If a life threatening emergency occurs, the following procedures must be implemented.

1. Evacuate the area
2. Call 2911 for life threatening emergencies.

This number will access the Emergency Coordinator, Plant Protection Central Alarm Station, Fire Department Dispatch Center, and the Medical Department. The plant protection central alarm station will activate the Building Emergency Support Team (BEST)

3. Provide as much information as possible including the following:

Your name  
Operable Unit  
Location of the emergency  
Type of emergency  
Condition of the injured  
Other hazards in the area

4. Other RFP groups may be notified. Radiological Engineering and Industrial Hygiene will assess the hazards associated with any spill. Waste operations will contain and clean up spills.

#### **17.6.5 Fire and Explosions**

The potential for fire or explosion is low. However, if an incident occurs, personnel will immediately evacuate the area and the fire department will be notified at extension 2911.

Personnel in the vicinity of the fire will determine if they can safely extinguish it. If they can, the fire extinguishers are provided in the vehicles, in the CRZ, or in the support zone:

If the fire is too big to extinguish with the use of an extinguisher, site personnel will immediately evacuate the area and wait for the EG&G fire department to arrive.

#### 17.6.6 Spills

Cleanup of incidental releases of hazardous substances can be performed with minimal risk to personnel if correct procedures are followed. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized or otherwise controlled at the time of release can be performed by employees in the immediate release area, if the responders are familiar with the potential safety and health hazards associated with the spill cleanup, and the appropriate precautions and personal protective equipment is used.

An example of incidental releases/spills that can be handled by site process personnel include:

- Spills of hazardous substances where the responders are familiar with the hazards (and PPE selection) associated with cleaning up the quantity of material spilled.

The HAZMAT team should be notified at extension 2911 if the spill or release of the hazardous substance cannot be absorbed, neutralized or otherwise controlled at the time of release by employees in the immediate release area. Additionally, HAZMAT should be notified if potential safety or health hazards (i.e. fire, explosion, or chemical exposure) exist. If the hazards associated with cleaning up the quantity of material is not known, or the correct PPE selection is not known, then HAZMAT should be called. Examples of situation that may require HAZMAT response include:

- Propane leak;
- Propane fire/explosion; or
- Forklift battery acid spill.

#### **17.6.7     Reporting**

The Waste Program department will decide if reports must be made under RCRA and CERCLA. The Response and Reporting department must also be notified of the incident at extension 7264.

A table listing the contractor's key emergency response personnel and their phone and pager numbers must be included at the end of this section.

#### **17.6.8     Emergency Decontamination**

The necessity for decontamination in emergency situations will be determined by EG&G Emergency Response personnel or the SSHO. If decontamination will interfere with, or delay life-saving care, it should be eliminated. If an injury is not life-threatening, but may aggravate the injury, decontamination should be avoided, the victim wrapped in a blanket or plastic cover to protect medical personnel.

#### **17.6.9     Emergency Medical Treatment and First Aid**

In the event of an injury, illness, or chemical exposure, the SSHO will evaluate the situation and determine appropriate action. If first aid or other treatment is required, the SSHO or his designate will notify the EG&G medical department. Injuries, illness, or exposure will be handled as indicated in Table 17.2.

Table 17.1 shows the required emergency equipment and the locations required for that equipment. Water in emergency shower and eye wash units will be changed weekly. Each unit will be inspected daily to ensure they are full. First aid kits will also be inspected weekly to ensure the kit is stocked adequately. If items are missing, they will be obtained and placed in the kits immediately. Fire extinguishers will be checked weekly to ensure full pressurization. All inspections will be conducted by the SSHO or designee.

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TABLE 17.1  
EMERGENCY EQUIPMENT REQUIREMENTS AND LOCATIONS

Equipment	Required Locations
2A-10B:C Dry Chemical Fire extinguisher	Each field vehicle, CRZ, shower/change facility
Industrial First Aid Kit	Support Zone office, shower/change facility, (kits in vehicles will be kept in sealable plastic bag)
Stretcher	Support Zone
Emergency Showers	CRZ
Emergency Eye Wash Units	CRZ and at least one field vehicle in EZ



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EMERGENCY TREATMENT FOR ACUTE INJURY, ILLNESS, AND EXPOSURE**

<b>Situation</b>	<b>Treatment</b>
Chemical Exposure - inhalation	Remove victim immediately from site, eliminate decontamination and remove person to fresh air. Administer CPR as necessary and seek medical assistance.
Chemical Exposure - skin contact	Remove person from area immediately. Remove protective clothing and wash individual with copious amounts of water. Seek medical assistance.
Heat Cramps	Remove individual from area to shady, cool area. Remove protective clothing and provide fluids.
Heat Exhaustion	Remove protective equipment immediately. Remove individual from area to cool area. Provide fluids and seek medical attention.
Heat Stroke	Remove protective equipment immediately. Remove individual from area and bathe in cool water. Seek immediate medical assistance.
Frostbite	Remove clothing and apply heat to affected limbs. Warm extremities in a bath of warm water (104° - 107°F). Do not rub or massage frozen areas.
Hypothermia	Contact emergency medical personnel. Move victim to shelter and remove wet clothing. Provide warm blankets, clothing, and beverages.
Physical Injury	Provide first aid and medical treatment as necessary.

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**17.6.10 EG&G Medical Department Location**

First aid activities will either occur in the field or at the EG&G Medical Department. The EG&G Medical Department is located outside the protected area in Building 122. From OU4, exit the protected area from the southeast security portal. Make a right onto Central Avenue and take Central Avenue to Building 122. The EG&G medical facility is located in Building 122.

A copy of the route map to the EG&G medical department will be placed in all site support vehicles. All site personnel will become familiar with the route and travel time required.

For medical problems which cannot be treated on plant site, EG&G uses St. Anthony Hospital. The EG&G medical department will determine if the patient should be transported to this hospital. If hospitalization is necessary, the patient will be transported by ambulance. To reach St. Anthony Hospital, leave the RFP by the east gate. Make a left on Indiana Street and a right on Highway 128. Take 128 to Wadsworth Boulevard (Highway 122), and make a right. Take Wadsworth to West 92nd Avenue and turn left. Take 92nd Avenue to Federal Boulevard (Highway 287) and make a right, then make a left on 84th Avenue. St. Anthony Hospital is located on the north side of the road at 2551 West 84th Avenue, in Westminster, Colorado. The phone number for St. Anthony Hospital is 426-2157.

**Weather-Related Emergency**

High winds, tornados, severe thunderstorms, and blizzards are possible at the RFP. In the event of a tornado, site personnel will evacuate to a safe area as directed by EG&G personnel or go to the nearest low lying area on the site and lay down. Decontamination will be bypassed. Personnel will not enter trailers or vehicles.

In the event of an impending thunderstorm, EG&G representatives and the SSHO will require a cessation of all site activities. Personnel will immediately proceed to the CRZ, decontaminate, and seek shelter. If the storm is fast-moving where personnel may be threatened by completing decontamination operation, personnel will evacuate the site immediately and seek adequate shelter as designated by EG&G representatives. This judgment will be made by the SSHO.

Work activities will not resume until EG&G representatives and the SSHO notify all personnel that all is clear. Upon this notice, the site will be surveyed for drainage and indications of releases or spread of hazardous substances. Response to any damage or hazard will follow all requirements of the HASP.

#### 17.7 EMERGENCY RESPONSE CRITIQUE AND FOLLOW-UP

Site activities will not resume following an emergency until the PHSM, SSHO, PM, and EG&G representatives, have ensured that all response equipment has been inspected, recharged, and prepared for another emergency. In addition, work will not resume until these individuals along with offsite emergency personnel have evaluated the response actions from the emergency. This evaluation along with all details of the emergency and the associated response will be kept in the project files. The evaluation will address the following areas:

- Cause of the incident;
- What could have prevented the incident;
- What procedures caused the incident and were response procedures appropriate and adequate;
- Has the site changed as a result of the incident, are there new hazards, or have hazards been eliminated; and

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- Was the community appropriately and adequately protected.

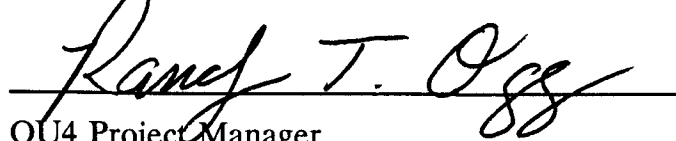
Once these areas have been adequately addressed, site activities will resume. The HASP will be modified to include the information generated as a result of the incident.

Documentation from the incident will be accurate, authentic, and complete. All documentation will be kept in the project file.

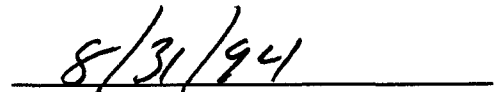
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## **18.0 STANDARD OPERATING PROCEDURES**

In addition to the detailed procedures and requirements of the HASP, common sense will prevail at all times. The following is a list of standard operating procedures to be adhered to by site personnel at all times.

### **18.1 PERSONNEL PRACTICES**

The following are rules and regulations to be followed by all contractor's and subcontractor personnel participating in field activities:

- The personal protective equipment required by the SSHO and this HASP shall be worn by all contractor and subcontractor personnel;
- Eating, drinking, chewing tobacco or gum, smoking, and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in the exclusion and contamination reduction zones;
- Contractor and subcontractor personnel shall not be allowed to wear contact lenses while wearing respirators;
- Alcoholic beverages shall not be allowed onsite;
- No individual shall engage in field activities without proper notification. Workers must also comply with the buddy system which will always be used for field activities during the RFI/RI;

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- Personnel should wash their hands and face thoroughly with soap and water prior to eating, drinking or smoking;
- Personnel will avoid contact with potentially impacted substances. Personnel shall not walk through puddles, pools, mud, etc. and will avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or ground. Monitoring equipment should not be placed on potentially impacted surfaces (i.e., ground, etc.);
- All field crew members should make use of their senses to alert them to potentially dangerous situations in which they should not become involved (i.e., presence of strong, irritating, or nauseating odors);
- Field team members will prevent, to the extent possible, spillages. In the event that a spillage greater than one pint or one pound occurs, EG&G personnel will contain and clean-up the spill. If the spill is smaller than this amount, it can be cleared by contractor or subcontractor employees;
- Field crew members will be familiar with the physical characteristics of the site, including:
  - Wind direction in relation to impacted area
  - Accessibility to equipment and vehicles
  - Communications
  - Areas of known or suspected constituents
  - Site access
  - Nearest water sources;
- The number of personnel and equipment in the impacted area should be minimized but only to the extent consistent with workforce requirements of safe site operations;
- All wastes generated during RFI/RI activities should be disposed of as directed by the EG&G and the PM; and
- All personal protective equipment should be used as specified and as required by the SSHO or PM.

## **18.2      WORK RESTRICTIONS**

All RFI/RI activities at the OU4 site will be conducted during daylight hours unless adequate lighting as approved by the SSHO is provided. Work will cease immediately upon the signs of impending thunderstorms and lightning, high winds, or other severe weather.

## **18.3      TRAFFIC HAZARDS**

Personnel will adhere to all Colorado and RFP traffic regulations and exercise due caution. Personal vehicles will not be allowed in the exclusion zone or contamination reduction zone. Seat belts where provided, must be worn at all times by all passengers while driving at the RFP.

## **18.4      HEAVY EQUIPMENT SAFETY**

Heavy equipment can represent a substantial hazard to workers. In general, requirements for motor vehicles and material handling equipment are provided in the OSHA Construction Industry Standard 29 CFR 1926, Subpart O. The following safe work practices (SWPs) should be followed when heavy equipment is in use:

- Use common sense. Workers should not assume that the equipment operator is keeping track of their whereabouts. Never walk directly in back of or to the side of, heavy equipment without the operators knowledge;
- Hard hats, steel toe boots, and safety glasses are to be worn at all times around heavy equipment. Other protective gear as specified in this health and safety plan is also applicable;
- Remain alert at all times;
- Maintain visual contact at all times;
- Establish hand signal communication when verbal communication is difficult. Determine one person per work group to give hand signals to equipment operators;

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- Be aware of footing at all times;
- Only qualified/licensed people are to operate heavy equipment;
- Use chains, hoists, straps, and any other equipment to safely aid in moving heavy materials;
- Use proper personal lifting techniques;
- The use of a piece of equipment will not occur by individuals who are not familiar with its operation. This applies to heavy as well as light equipment (i.e., jackhammers);
- Be sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines, will present a hazard in the work area;
- Keep all non-essential people out of the work area;
- Prohibit loose-fitting clothing or loose long hair around moving machinery;
- Keep cabs free of all non-essential items and secure all loose items;
- Instruct equipment operators to report to their supervisor(s) any abnormalities such as equipment failure, oozing liquids, unusual odors, etc.;
- When an equipment operator must negotiate in tight quarters, provide a second person to ensure adequate clearance;
- Implement an ongoing maintenance program for all tools and equipment. Inspect all tools and moving equipment regularly to ensure that parts are secured and intact with no evidence of cracks or areas of weakness that the equipment turns smoothly with no evidence of wobble and that it is operating according to manufacturer's specifications. Promptly repair or replace any defective items. Keep maintenance and repair logs;
- Store tools in clean, secure areas so that they will not be damaged, lost or stolen;
- Keep all heavy equipment that is used in the exclusion zone in that zone until the job is done. Completely clean such equipment within the designated vehicle decontamination pad;



- Vehicles may not have cracked windshields or windows;
- Blades, buckets, dump bodies, and other hydraulic systems must be fully lowered when equipment is not in use;
- Parking brakes shall be engaged when equipment is not in use;
- All vehicles with rollover protective structures (ROPS) will have seat belts; operators will be trained in the use of seat belts, and the seat belts shall be used at all times during vehicle operation;
- With certain exceptions provided in 29 CFR 1926, Subpart O, all material handling equipment will be provided with ROPS;
- Equipment with an obstructed rear view must have an audible alarm that sounds when it is operating in the reverse direction (unless a spotter guides the vehicle operator);
- Material handling equipment that lacks a ROPS must not be operated on a grade, unless the grade can safely accommodate the equipment involved;
- A safety barrier will be used to protect workers whenever a tire is inflated, removed, or installed on split rims; and
- Heavy equipment will be inspected by the operator prior to the beginning of each work shift, and the SSHO shall ensure the compliance to this regulation.

## **18.5      EG&G SOPS**

The RFI/RI involves OU wide radiological survey, surficial soil sampling and vadose zone monitoring. In addition, field sampling and geophysical investigations will be performed in the vicinity of the original pond, in the existing solar ponds, and in the interceptor trench system. Furthermore, some boreholes will be drilled off site. The activity and corresponding EG&G Standard Operating Procedures (SOPs) which apply to OU4 activities are described below:

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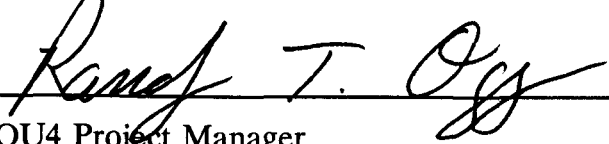
- F0.1 Windblown Contaminant Dispersion Control
- F0.2 Field Document Control
- F0.3 General Equipment Decontamination
- F0.4 Heavy Equipment Decontamination
- F0.5 Handling Purge and Development Water
- F0.6 Handling of Personal Protective Equipment
- F0.7 Handling of Decontamination Water and Wash Water
- F0.8 Handling of Drilling Fluids and Cuttings
- F0.9 Handling of Residual Samples
- F0.10 Receiving, Labeling, and Handling of Waste Containers
- F0.11 Field Communications
- F0.12 Decontamination Facility Operations
- F0.13 Containerizing, Preserving, Handling, and Shipping Soil and Water Samples
- F0.14 Field Data Management
- F0.15 Use of Photoionizing and Flame Ionizing Detectors
- F0.16 Field Radiological Measurements
- F0.18 Environmental Sample Radioactivity Content Screening
- GW.1 Water Level Measurements in Wells and Piezometers
- GW.2 Well Development
- GW.5 Measurement of Ground Water Field Parameters
- GW.6 Ground Water Sampling
- GT.1 Logging Alluvial and Bedrock Material
- GT.2 Drilling and Sampling Using Hollow-Stem Auger Techniques
- GT.3 Isolating Bedrock from Alluvium Using Grouted Surface Casing
- GT.4 Rotary Drilling and Rock Coring
- GT.5 Plugging and Abandonment of Wells
- GT.6 Monitoring Well and Piezometer Installation
- GT.8 Surface Soil Sampling
- GT.10 Borehole Clearing
- GT.15 Geophysical Borehole Logging
- GT.18 Surface Geophysical Surveys
- GT.20 Installation of Lysimeters

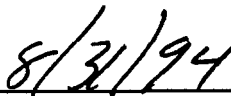
A copy of all EG&G SOPs will be kept onsite.

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## 19.0 RCRA PERMITS AND NEW TECHNOLOGIES

### 19.1 RCRA PERMITS

Since the Solar Ponds are a hazardous waste treatment and storage facility, work activities are ruled by RCRA and the State of Colorado's hazardous materials regulations. In accordance with 40 CFR 265 and 6 CCR 1007-3, the Solar Ponds facility is presently in an interim permitting status. This interim status will terminate in November 1992. As site operations and conditions change, EG&G may have to amend their permit limitations and/or their operating standards. As operations change throughout OU4, this HASP will be revised accordingly.

### 19.2 NEW TECHNOLOGIES

In 29 CFR 1910.120, OSHA requires the operators of all treatment, storage and disposal facilities (TSD) to develop and implement new technologies and equipment developed for employee protection. Since EG&G operates TSD facilities at the RFP, all new product and technology evaluations must be documented. Several departments are responsible for the evaluation of new products and technologies. These departments and their responsibilities are listed in Table 19.1.

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**TABLE 19.1  
EVALUATION PROCEDURES BY EG&G DEPARTMENT**

<b>PRODUCTS or TECHNOLOGIES</b>	<b>DEPARTMENT</b>
Chemical Protection Clothing & Respiratory Protection	INDUSTRIAL HYGIENE
Protection Equipment used to protect against falls, impacts, explosions, and related safety concerns	INDUSTRIAL SAFETY, ENGINEERING
Radiation Safety Protective Equipment	RADIOLOGICAL ENGINEERING
Chemical Exposure Monitoring	INDUSTRIAL HYGIENE
Radiation Exposure Monitoring	RADIOLOGICAL ENGINEERING
Fugitive Particulate and Vapor Emission Controls Engineering	INDUSTRIAL HYGIENE, RADIOLOGICAL ENGINEERING
Chemical or Radiological product spill containment, neutralization, stabilization, evaporation, and storage	RADIOLOGICAL ENGINEERING, ENGINEERING
Material Handling	INDUSTRIAL SAFETY, ENGINEERING

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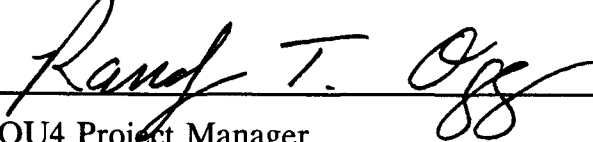
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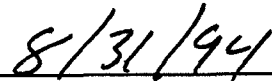
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## 20.0 LOGS, RECORDS, AND REPORTS

A safety log book and various forms will be kept by the SSHO to document events related to safety during RFI/RI activities. General procedures that pertain to the use of all log books and log forms include recording on each page of the safety log books: the initial of persons making the entry; date and time of each entry (military time); a description of the activities as they are occurring; and location. Each log or form will be signed at the end of each day or work shift. All blanks on a form will be filled in with appropriate information of the words "none" or "not applicable" (NA). All entries will be made in ink. No pages will be removed from the log book.

Daily safety briefings will be recorded in the safety log book. This log will include an outline of the topics discussed and the names of personnel attending.

A variety of records will be collected and organized prior to and during field activities, including:

- Training logs;
- Employees and visitors' log;
- Medical information;

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- Accident Report;
- Daily Inspection Logs;
- Daily Safety Log;
- Air monitoring and calibration log; and
- Radiological monitoring records.

Medical records (Section 16.0) Accident Reports (Section 13.0), Daily Inspection Logs (Section 13.0), and Air Monitoring Records and Logs (Section 8.0) are discussed in their specific section of the HASP. The remaining records, logs, and reports to be maintained before, during, and after the project are detailed below.

## **20.1 TRAINING LOGS**

In addition to the training records to be kept onsite as described in Section 9.0 of this HASP, records which will be kept for site-specific training include:

- Course participant's name, signature and social security number;
- A copy of the course agenda which includes the topics discussed and the time allotted for each topic; and
- The signature of the trainer and date.

Appendix I is an example of the form to be used for documenting the site-specific training.

## **20.2 EMPLOYEES AND VISITORS LOG**

All employees and visitors will be required to sign a daily log in order to document who was onsite and when. This log will be maintained by the SSHO or PM and include the following information:

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- Date;
- Name of visitor or employee;
- Address;
- Representing agency or company;
- Reason for being onsite;
- Time entering the site; and
- Time exiting the site.

This log will be maintained in a bound notebook labeled visitors and employee log. The log will be kept near the entrance to the office trailer in the support zone.

### **20.3 DAILY INSPECTION LOGS**

The SSHO will maintain a daily safety log in a bound notebook. Each page of the notebook will be dated with a new day starting on a new page. Unused portions of a page will have a line placed through it and initialled. The end of the daily entry will be signed and dated by the SSHO. The daily safety log will include:

- Date;
- Activities to be completed that day;
- Weather information;
- Locations of site personnel
- Equipment being used by onsite personnel;
- PPE being worn by all onsite employees and visitors;

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- Air monitoring data;
- A log of activities, conversations, meetings, telephone calls pertaining to safety, etc., including the times they occurred; and
- The SSHO signature and date.

#### **20.4      OSHA RECORDKEEPING**

All medical and employee exposure records will be maintained per 29 CFR 1910.20. These records will be maintained for the duration of employment of each employee plus an additional 30 years. These records are accessible to employees upon their request.



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**CONTROLLED DOCUMENT**  
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ENVIRONMENTAL MANAGEMENT

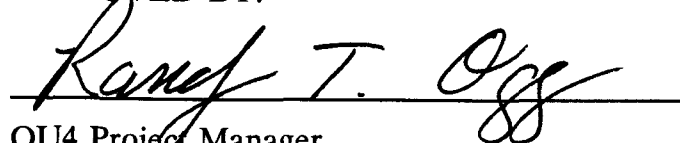
INFORMATION  
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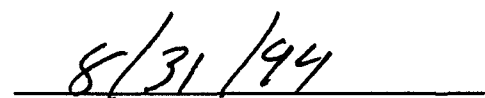
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**EG&G ROCKY FLATS PLANT  
FINAL REPORT HEALTH AND SAFETY PLAN  
FOR OPERABLE UNIT 4, SOLAR  
EVAPORATION PONDS  
ROCKY FLATS PLANT**

**Manual No.: RFP/ERM-94-00037  
Revision No.: Rev. 0  
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Effective Date: SEP 15 1994  
Organization: ERM**

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EG&G ROCKY FLATS PLANT  
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**APPENDIX A**

**HEALTH AND SAFETY PLAN ACCEPTANCE STATEMENT**

## ACCEPTANCE STATEMENT

I am familiar with the Health and Safety Plan (HASP) for the RFI/RI activities to be performed at Operable Unit 4 at the Rocky Flats Plant. I understand the contents of the HASP and any questions I had regarding the HASP have been satisfactorily answered. I agree to comply with the information contained in this document.

[illegible]

**APPENDIX B**  
**FIELD CHANGE FORM**



**CONTRACTOR  
FIELD CHANGE FORM**

Project Number: \_\_\_\_\_

Date Effective: \_\_\_\_\_

Requested By: \_\_\_\_\_

Name

\_\_\_\_\_

Date

\_\_\_\_\_

Signature

\_\_\_\_\_

Title

Reason For Change:

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Text of Change:

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## FIELD CHANGE FORM

Project Number: \_\_\_\_\_

\_\_\_\_\_  
Project Health and Safety Manager Date

\_\_\_\_\_  
Program Manager Date

\_\_\_\_\_  
Project Manager Date

\_\_\_\_\_  
EG&G Health and Safety Liaison Officer Date

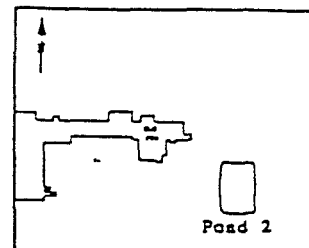
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EG&G Project Manager Date

**APPENDIX C**  
**SITE HISTORY**

## SOLAR POND HISTORY TIMELINE

October 1953 - Construction of the first clay-lined evaporation pond, Pond 2, was complete (RYAN, E.S., DOW CHEMICAL COMPANY 1953, "PROGRESS REPORT - WASTE DISPOSAL UNIT - OCTOBER 1953," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, NOVEMBER 6).

December 1953 - Waste was first sent to Pond 2 (RYAN, E.S., DOW CHEMICAL COMPANY, 1953, "PROGRESS REPORT - WASTE DISPOSAL UNIT - DECEMBER 1953," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, JANUARY 7).



June 1954 - Leakage from solar pond was first noted based on the existence of a nitrate-contaminated spring on the hillside to the north of the solar pond (RYAN, E.S., DOW CHEMICAL COMPANY 1954, "PROGRESS REPORT - WASTE DISPOSAL UNIT - JUNE 1954," INTERNAL LETTER TO H.C. ANDERSON, DOW CHEMICAL COMPANY, JULY 8).

November 1954 - A series of tests was initiated to determine whether disposing of contaminated coolant into solar pond would be practical (RYAN, E.S., DOW CHEMICAL COMPANY, 1954, "PROGRESS REPORT FOR THE MONTH OF NOVEMBER 1954 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, DECEMBER 2).

January 1955 - The coolant evaporation study was temporarily discontinued due to increased operation of the coolant still in Building 444 (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF JANUARY 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, FEBRUARY 2).

February 1955 - The spring to the north of the solar pond was sampled twice a week; analyses indicated an increasing nitrate concentration (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF FEBRUARY 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MARCH 2).

April 1955 - Planning began for the replacement of Pond No. 2 (the original evaporation pond) with two new water tight ponds, each with a capacity of 500,000 gallons (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF APRIL 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MAY 2).

May 1955 - RFP personnel become aware that Great Western Reservoir (field trip to Great Western Reservoir on May 4, 1955) was to be used as a drinking water supply; there was concern regarding movement of nitrates offsite from the Solar Pond area. It was decided to build a "water-tight" solar pond (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF MAY 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JUNE 1).

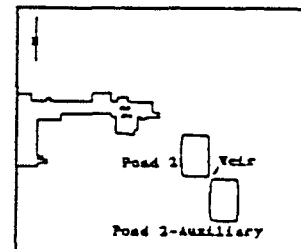
June 1955 - Pond No. 2 required repairs due to liquid appearing south and east of the pond; clay fill was used to prevent seepage (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF JUNE 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JULY 1).

July 1955 - Construction of Broomfield Heights homes began. This activity made the construction of a water tight pond more of a priority than it was previously (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF JULY 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, AUGUST 1).

August 1955 - Inspection of Pond 2 revealed another leak on the east side of the pond, and that the pond was too full and would soon overflow. It was suggested that, since the 2 proposed water

tight ponds were not under construction yet, excavation be made for the construction of a 1-acre clay-lined pond adjacent to the existing evaporation pond (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF AUGUST 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, SEPTEMBER 1).

September 1955 - A second pond was constructed catty-corner (to the southeast) to Pond 2, due to the lack of capacity in Pond 2. This new pond was designated Pond 2-Auxiliary, and was of earthen construction with no liner whatsoever. Waste only flowed into the pond from a common corner over a weir. Leaks were observed along the east side of the new pond during this same month (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF SEPTEMBER 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, OCTOBER 4).



October 1955 - As a result of a lower liquid level in Pond No. 2, the leaks along the east side of the auxiliary pond subsided (RYAN, E.S., DOW CHEMICAL COMPANY, 1955, "HISTORY REPORT FOR THE MONTH OF OCTOBER 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 3).

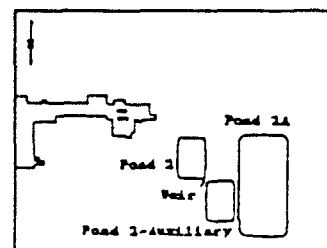
December 1955 - Due to wind, water from Pond 2 was blown to the east. A request for soil and vegetation sampling was made from Waste Disposal to Industrial Hygiene (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF DECEMBER 1955 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JANUARY 4).

January 1956 - Excavation of the first synthetically lined pond (originally designated Pond 2A, later re-designated Pond 207A) began (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF JANUARY 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, FEBRUARY 2).

April 1956 - The subgrade for the water tight pond was completed. Placement of the 3 foot by 14 foot asphalt-impregnated felt planking for the lining began (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF APRIL 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MAY 1).

May 1956 - Placement of the asphalt lining was completed, and the process of sealing the lining began. A request for the necessary piping changes were made. The changes would allow for direct transfer of certain wastes from Buildings 444 and 881 to the newest evaporation pond. Leaks appeared in the east dike of the original Pond 2 and in the north dike of the auxiliary pond. Clay fill was used to prevent the seepage. It was requested that the auxiliary pond be lined (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF MAY 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JUNE 5).

June 1956 - Construction and lining of the "Facility 207 Asphalt Lined Evaporation Pond" was completed. One discharge line had been installed, and another was in the process of being installed. Inspection of the pond revealed that the felt was separated from the asphalt on several sheets. Corrective action was to be taken. It was recommended that test wells be installed around the new pond for analysis of groundwater. The number of seepage leaks from Pond 2 had decreased. It was stated that the auxiliary



pond needed clay lining (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF JUNE 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JUNE 29).

July 1956 - The faulty asphalt sheets were repaired (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF JULY 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, AUGUST 3).

August 1956 - Pond 207A was placed in limited use (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF AUGUST 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, SEPTEMBER 5). Ponds 2 and 2-Auxiliary were taken out of service and being allowed to dry (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

September 1956 - Dow's approval of the stainless steel pipeline allowed for direct release of liquids to the new pond. Pond 2-Auxiliary was being allowed to dry, and would be clay lined when it was dry (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR THE MONTH OF SEPTEMBER 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, OCTOBER 2).

October 1956 - Stainless steel extension tubes were attached to the end of the discharge pipes on the new pond, resulting in releases of liquid from 18 inches above the pond floor. Approximately 2/3 of the pond floor was covered with liquid at this time (RYAN, E.S., DOW CHEMICAL COMPANY, 1956, "HISTORY REPORT FOR OCTOBER 1956 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 5).

January 1957 - Lining of Pond 2-Auxiliary with clay began. Samples of the nitrate spring were still being taken (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT FOR THE MONTH OF JANUARY 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, FEBRUARY 4). The "unused pond near 77 Building" was filled for abandonment, due to construction of the asphalt pond (SMITH, R.D., DOW CHEMICAL COMPANY, 1957, "MONTHLY PROGRESS REPORT - SITE SURVEY - JANUARY 1957," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, FEBRUARY 5).

February 1957 - Lining of the auxiliary pond was completed. Clay was placed on the inner face of the east dike of Pond 2, which was dry, to prevent leakage which had developed while the pond was in use (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT FOR THE MONTH OF FEBRUARY 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MARCH 4).

March 1957 - Lining of the inner face of the sides of Pond 2 was complete. A wooden spillway was installed below the three discharge pipes, and the pond was returned to service (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT FOR THE MONTH OF MARCH 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, APRIL 5).

April 1957 - Releases of wastes from Buildings 883 and 774, which were above drinking water tolerance levels, were made to Pond 2A. Six hundred gallons of salt bath solution were also (?) released to Pond 2A (or was the waste the bath solution?). Activity build-up in the pond was being investigated (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT FOR THE MONTH OF APRIL 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MAY 3).

June 1957 - The study of the activity build-up in Pond 2A was ongoing. The study was a result of a request from Building 881 for higher release levels (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT FOR THE MONTH OF JUNE 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JULY 5).

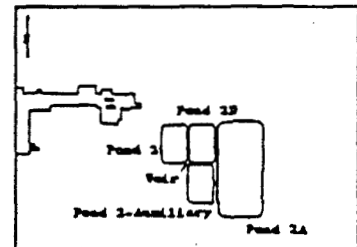
July 1957 - Seven drums of contaminated wash water from decontamination of production personnel was disposed of in Pond 2A. An investigation of possible auxiliary evaporation for Pond 2A was initiated. The study involved determining an appropriate evaporation booster, such as a tower or spray, to extend the life of the pond (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT - JULY 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, AUGUST 5).

October 1957 - An 8-foot chain link fence was constructed around Ponds 2 and 2A. Studies of the use of clay to reduce activity in the Pond 2A were initiated (RYAN, E.S., DOW CHEMICAL COMPANY, 1957, "HISTORY REPORT - OCTOBER 1957 - WASTE DISPOSAL CO-ORDINATION GROUP," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 5).

September 1958 - Aluminum paint was applied to the exposed surface of Pond 2A to increase evaporation (RYAN, E.S., DOW CHEMICAL COMPANY, 1958, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - SEPTEMBER 1958," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, OCTOBER 8).

October 1958 - A request for authorization for construction of another asphalt-lined pond was submitted. The second pond was needed in case Pond 2A ruptured and leaked, and for additional evaporative surface area (RYAN, E.S., DOW CHEMICAL COMPANY, 1958, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - OCTOBER, 1958," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 6).

April 1959 - A third earthen pond was constructed to prevent overflowing of Pond 2A. Plans for a method to mix Pond 2 liquid with Pond 2A liquid to enable transfer to Building 995 were being made as another attempt to lower the liquid level in Pond 2A (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - APRIL 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MAY 12). The new pond was located just east of Pond 2, west of Pond 207A, and north of 2-Auxiliary. This new pond is believed to have been designated Pond 2D, with 2-Auxiliary being designated 2C.



May 1959 - Plans for the use of Pond 2 as an oxidation unit using liquids from Pond 2A were being made (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - MAY 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JUNE 8).

June 1959 - Monitoring of the "dumping of alcohol wash from Building 77 into the nitrate pond east of Building 77" was conducted. Following the release, the area above the water line where the wash had been dumped had greater than 100,000 cpm (HILL, J.E., DOW CHEMICAL COMPANY, 1959, "MONTHLY PROGRESS REPORT - SITE SURVEY - JUNE 1959," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, JULY 6). Various analyses were taken of the pond area, results of which were as follows: 1,040 dpm/l water sample at the nitrate pond; 2 dpm/l water sample at the spring on the north slope of the nitrate pond; and  $2.7 \times 10^6$  dpm/kg 100 feet east of the nitrate pond (normal soil background was reported to be  $2 \times 10^4$  to  $5 \times 10^4$  dpm/kg) (HAMMOND, S.E., Dow

CHEMICAL COMPANY, 1959, "MONTHLY PROGRESS REPORT - SITE SURVEY - JUNE 1959," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, JULY 6).

July 1959 - The flow pattern of Pond 2 was modified to allow for maximum detention prior to release of the wastes to the sanitary system. The use of Pond 2 as an oxidation pond using liquid from Pond 2A was initiated (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JULY 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, AUGUST 10). Monitoring of the sides of the nitrate pond indicated direct readings of greater than 100,000 cpm and smears up to 300,000 dpm (HILL, J.E., DOW CHEMICAL COMPANY, 1959, "MONTHLY PROGRESS REPORT - SITE SURVEY - JULY 1959," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, AUGUST 3).

August 1959 - The dikes on the east sides of Ponds 2C and 2D were raised to provide additional storage volume. Liquids were transferred to Pond 2 instead of Pond 2A whenever possible in an effort to lower the volume of Pond 2A. Water from Pond 2D was pumped to the sanitary system for a period of 7 hours to determine the affect of the liquid on the system. Results were favorable. Another test, with a pumping period of three days, was also conducted (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - AUGUST 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, SEPTEMBER 9).

September 1959 - The results of the second aforementioned test indicated that the process was unfavorable. Investigation into nitrate reduction methods was conducted using sulfur dioxide gas and air, with unsuccessful results. A study of nitrate reduction using aluminum was initiated (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - SEPTEMBER 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, OCTOBER 7).

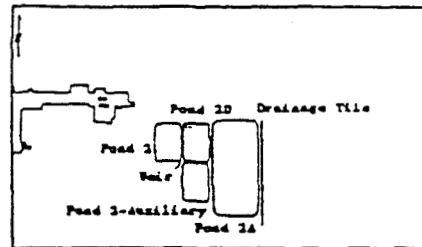
October 1959 - It was recommended that the dikes of the ponds be built up for the winter. Bids for construction of the second asphalt-lined pond were sent to ALO for final selection and approval. It was stated that, when the new pond was built, the level of the existing asphalt-lined pond would be lowered to make repairs to planking and sun-checked surface (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - OCTOBER 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 5).

November 1959 - Construction of the second lined solar pond began. Wind caused considerable spray of pond water, hindering construction activities (RYAN, E.S., DOW CHEMICAL COMPANY, 1959, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - NOVEMBER 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, DECEMBER 10). This pond was to consist of three separate cells, and was also constructed of asphalt planking. The designation for this pond was Pond 2B-North, Center, and South, later changed to Pond 207B-North, Center, and South. Direct readings of the bank of Pond 2A indicated between 250 and 100,000 cpm. High winds spread salt onto equipment parked east of the pond, but there was no indication of contamination (HILL, J.E., DOW CHEMICAL COMPANY, 1959, "MONTHLY PROGRESS REPORT - SITE SURVEY - NOVEMBER, 1959," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, DECEMBER 3). Samples of the spring on the north slope of the nitrate pond indicated 14 dpm/l (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1959, "SITE SURVEY MONTHLY REPORT - NOVEMBER 1959," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, DECEMBER 9).

December 1959 - Seepage noted at the west end of the 207B pond excavation and a "covered drainage ditch" was constructed to drain the water to the hillside north of the ponds. Samples of the seepage were analyzed daily. The sand and gravel bed was packed in the southern section of the excavation, and a sterilant was applied. The sterilant was then covered with asphalt



planking (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - DECEMBER 1959," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JANUARY 11). (No details on the length or invert elevation of the covered drainage ditch has yet been found on this pipe - I believe the man with the best information on it has passed away.) Water samples indicated 84 dpm/l in seepage from the nitrate pond, and 10.5 dpm/l in the spring on the north slope, with enriched uranium being the major component of the activity in the spring water (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1960, "MONTHLY PROGRESS REPORT - SITE SURVEY - DECEMBER 1959," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, JANUARY 13).

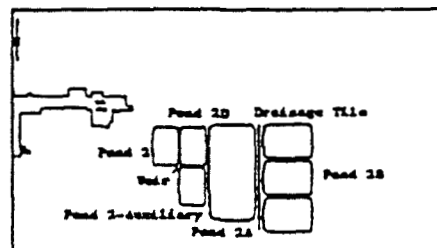


March 1960 - Connecting pipes between the sections of the new asphalt-lined pond, as well as controlling valves, were installed. Cuts in the dike for the connecting pipes were backfilled. Construction of the pump station began. Connecting pipes and control valves from the existing pipes to Pond 2A were installed, completing the pipeline from the new valve pit to the inlet of the new pond. High activity in the effluent, as determined through composite samples from the drainage tile, was attributed to liquids being carried from Pond 2A by high winds (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - MARCH 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, APRIL 11).

April 1960 - Construction activities on the pumping station for the new asphalt-lined pond continued. Placement of planking, as well as mastic application, was completed on the south section. Planking had also been placed in the center and north section, and mastic application had begun. High winds again affected activity levels in the effluent (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - APRIL 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, MAY 6).

May 1960 - Waste was released into the newly completed cells, 207B-Center and South (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - MAY 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JUNE 7). Water samples indicated 2.7 dpm/l at the spring north of the nitrate pond (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1960, "MONTHLY PROGRESS REPORT - SITE SURVEY - MAY 1960," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, JUNE 10).

June 1960 - The 207B Solar Ponds, referred to as Pond 2B, were fully completed. Transfer of water from Pond 2A was halted when leaks were discovered in the south and center sections. In order to return the liquid to Pond 2A, it first had to be transferred to the north section, resulting in extensive damage to the north section of the new pond. The problems were caused by the acidic wastes reacting with the soil and producing gas, which lifted the asphalt planking and ruptured the seams. Investigations into the use of sodium sulfite and sulfur dioxide as reducing agents in high nitrate waste were unsuccessful (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JUNE 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, JULY 15). Routine use of the earthen ponds, Ponds 2, 2-Auxiliary and 2C, ceases. (The only other known release to these ponds occurred in March 1963). Water samples indicated 3.1 dpm/l in the spring north of the nitrate



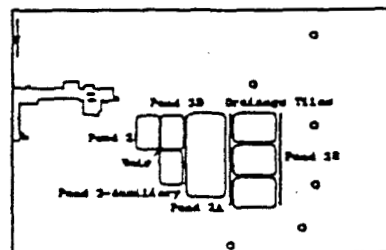
pond (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1960, "MONTHLY PROGRESS REPORT - SITE SURVEY - JUNE 1960," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, JULY 11).

July 1960 - All wastes had been transferred from Pond 2B to Pond 2A. The planking of Pond 2B was cut in some areas in order to relieve the pressure from the gas underneath the planking. A stainless steel flashing was constructed and welded around the connecting pipe between the south and middle sections of the pond (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JULY 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, AUGUST 17). Water samples indicated 4.4 dpm/l in the spring north of the nitrate pond (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1960, "MONTHLY PROGRESS REPORT - SITE SURVEY - JULY 1960," INTERNAL LETTER TO T.S. CHAPMAN, DOW CHEMICAL COMPANY, AUGUST 9).

September 1960 - Monitoring of the "three east nitrate ponds" indicated maximum readings of 2,000 cpm direct and 200 dpm removable (HILL, J.E., DOW CHEMICAL COMPANY, 1960, "MONTHLY PROGRESS REPORT - SITE SURVEY - SEPTEMBER 1960," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, OCTOBER 5).

October 1960 - Bids received for relining of the 207B ponds were too high. A request for re-bids for lining only the south section was made, and one was accepted (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - OCTOBER 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, NOVEMBER 11).

November 1960 - The south section of Pond 207B was relined, using asphalt concrete, and seal-coated. The first six groundwater wells were also installed in the immediate vicinity of 207B solar ponds (RYAN, E.S., DOW CHEMICAL COMPANY, 1960, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - NOVEMBER 1960," INTERNAL LETTER TO L.C. FARRELL, DOW CHEMICAL COMPANY, DECEMBER 16).



December 1960 - Pond 207B was again placed into service, but was to be used only for treated alkaline wastes from Building 774 (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - DECEMBER 1960," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, JANUARY 26).

January 1961 - The six monitoring wells were sampled for the first time (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JANUARY 1961," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, FEBRUARY 15).

April 1961 - Preparation for the repair of 207B-Center and North began. The center section was drained, and dirt and gravel were removed. The north section was pumped out (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - APRIL 1961," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, MAY 19). Work activities at this time included the construction of a drainage tile immediately east of the ponds to intercept any leakage flowing to the east. Underdrains in the ponds themselves were not constructed. The asphalt concrete was placed over the asphalt planking except in 207B-North, where difficulties were encountered and the planking was removed. Concern was centered on 207A, which was believed to be leaking.

- June 1961 - Cleaning and draining of 207B-Center and North in preparation for repair was completed (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JUNE 1961," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, JULY 11).
- July 1961 - Repair on the north and center sections of Pond 207B began. Because of difficulty in laying the asphalt concrete over the asphalt planking, the planking was removed in the north section. A rupture occurred in the asphalt concrete in the south section of the pond, near the outlet from Building 774. Pumping was transferred to Pond 2A so that repairs could be made (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - JULY 1961," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, AUGUST 18).
- August 1961 - Ponds 207B-Center and North were returned to service. The contents of the south section were transferred to the center section, and were mixed with sodium silicate as they passed through the transfer pipe. The three sections were then equalized, and spill boxes were installed at the ends of the discharge pipes. The north section was then closed off for use in spray evaporation studies (RYAN, E.S., DOW CHEMICAL COMPANY, 1961, "HISTORY REPORT - WASTE DISPOSAL CO-ORDINATION GROUP - AUGUST 1961," INTERNAL LETTER TO J.G. EPP, DOW CHEMICAL COMPANY, SEPTEMBER 26).
- October 1961 - Prior to spraying operations at the nitrate pond, background surface readings and soil samples were taken. Air samples taken during spraying indicated very little airborne activity (HILL, J.E., DOW CHEMICAL COMPANY, 1961, "MONTHLY PROGRESS REPORT - SITE SURVEY - OCTOBER 1961," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, NOVEMBER 6).
- February 1962 - The pipeline between the center and north section of Pond 207B was reopened to allow transfer. Spray evaporation had not yet been attempted, and the line would be closed when the study began (RYAN, E.S., DOW CHEMICAL COMPANY, 1962, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - FEBRUARY 1962," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, MARCH 20).
- March 1962 - During routine inspection of Pond 2A, several breaks in the asphalt planking were discovered. Liquid was transferred to Pond 2B using a large portable pump. This was the first transfer using the pump from Pond 2A to Pond 2B. It was also discovered at this time that liquid was leaking beneath the planking, seeping into the drainage tile, and being mixed with water in Pond 1 (RYAN, E.S., DOW CHEMICAL COMPANY, 1962, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - MARCH 1962," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, APRIL 18). Silicate was going to be applied to the soil beneath the leak in the planking; however, as of May 10, 1962, this had not yet been done (RYAN, E.S., DOW CHEMICAL COMPANY, 1962, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - APRIL 1962," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, MAY 10).
- July 1962 - Water samples indicated 1.8 microcuries per liter in the spring on the northeast slope of the nitrate pond (RAY, E.L., DOW CHEMICAL COMPANY, 1962, "MONTHLY PROGRESS REPORT - SITE SURVEY - JULY 1962," INTERNAL LETTER TO C.W. PILTINGSRUD, DOW CHEMICAL COMPANY, AUGUST 9).
- September 1962 - Work on the removal of Pond 2-Auxiliary begins due to the anticipated construction of Building 779, some of which will be over Pond 2-Auxiliary. The floor of the clay-lined pond was monitored prior to the arrival of construction personnel, with results of up to 5,000 cpm. Waste disposal analyses of soil indicated 11,000 to 75,000 dpm/kg. It was recommended that the soil be removed prior to construction activities (HILL, J.E., DOW CHEMICAL COMPANY, 1962, "MONTHLY PROGRESS REPORT - SITE SURVEY - INDUSTRIAL HYGIENE - SEPTEMBER 1962," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, OCTOBER 2).

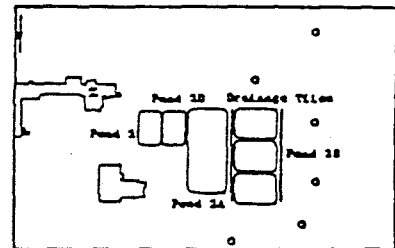
- October 1962 - The clay lining was removed from Pond 2-Auxiliary. Monitoring indicated low surface contamination (HILL, J.E., DOW CHEMICAL COMPANY, 1962, "MONTHLY PROGRESS REPORT - SITE SURVEY - INDUSTRIAL HYGIENE - OCTOBER 1962," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, NOVEMBER 5).
- November 1962 - Monitoring of the "large nitrate pond" indicated 500 to 1,000 cpm direct on the exposed surfaces. Analyses of the salt indicated 1,500 to 2,000 dpm/g. Rebuilding of this pond was pending (HILL, J.E., DOW CHEMICAL COMPANY, 1962, "MONTHLY PROGRESS REPORT - SITE SURVEY - INDUSTRIAL HYGIENE - NOVEMBER 1962," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, DECEMBER 3).
- February 1963 - Small cracks were discovered in the asphalt concrete of Pond 2B (specific section not mentioned) (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - FEBRUARY 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, MARCH 14).
- April 1963 - Relining work on 207A begins with the removal of salts and cleaning of exposed lining (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - APRIL 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, MAY 20).
- May 1963 - The north section of Pond 207B was pumped as low as possible, and cracks in the sides of the pond were sealed. Forty drums of contaminated aluminum scrap were dumped in Pond 2A. Laboratory studies of evaporation were conducted for development of an evaporation unit for high nitrate aqueous wastes (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - MAY 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, JUNE 17).
- June 1963 - Transfer of Pond 2A contents to Pond 2B with an addition of caustic began. Three trailer loads of caustic were added to Pond 2B, and five trailer loads were added to Pond 2A (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - JUNE 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, JULY 30).
- July 1963 - The transfer of liquids from Pond 2A to Pond 2B was completed. A small heel of remaining acid waste was neutralized by pumping basic wastes from 207B-South to Pond 2A, and then from Pond 2A to the 207B-North. A test of the burning capabilities of Pond 2A lining was made to evaluate it as a method of disposal. The planking was not combustible alone, and required fuel for burning (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - JULY 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, AUGUST 19).
- August 1963 - Removal of plank lining and sand sub-grade from Pond 2A began (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - AUGUST 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, SEPTEMBER 19). Vegetation samples taken from the southwest corner of the "main nitrate pond" indicated 960 dpm/kg (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1963, "MONTHLY PROGRESS REPORT - SITE SURVEY - AUGUST 1963," INTERNAL LETTER TO C.W. PILTNGSRUD, DOW CHEMICAL COMPANY, SEPTEMBER 9).
- September 1963 - Removal of asphalt planking and excavation work for 207A re-design was completed (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - SEPTEMBER 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, OCTOBER 16). The planking was disposed of in Trench T-4. The planking contained approximately 16.2 grams of uranium (FREIBERG, K.J., DOW CHEMICAL COMPANY, 1973, "MONTHLY STATUS REPORT - HEALTH PHYSICS OPERATIONS. TECHNICAL AND CONSTRUCTION - NOVEMBER 1973," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL

COMPANY, DECEMBER 4). Vegetation samples taken from the northeast corner of the nitrate ponds indicated 310 dpm/kg (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1963, "MONTHLY PROGRESS REPORT - SITE SURVEY - SEPTEMBER 1963," INTERNAL LETTER TO C.W. PILTINGSRUD, DOW CHEMICAL COMPANY, OCTOBER 15).

October 1963 - Relining and reforming of Pond 2A began. The pond was to be lined with two asphalt concrete mats (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - OCTOBER 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, NOVEMBER 14).

November 1963 - The re-design of 207A was completed (RYAN, E.S., DOW CHEMICAL COMPANY, 1963, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - NOVEMBER 1963," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, DECEMBER 16).

January 1964 - The process waste lines to the asphalt ponds were relocated. This was necessary because of the construction of Building 779 (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - JANUARY 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, FEBRUARY 13).



March 1964 - Extensions on the Pond 2A discharge pipes were installed, as was a trough from the extensions to the bottom of the pond (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - MARCH 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, APRIL 15).

April 1964 - The coupling of a 1,600 gpm pump at Pond 2A was completed (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - APRIL 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, MAY 18).

May 1964 - Transfer of wastes from 207B-North to 207A was made (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - MAY 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, JUNE 17).

June 1964 - Wastes were transferred from 207B-North and Center to 207A. The exposed portions of Pond 207B were inspected (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - JUNE 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, JULY 29).

July 1964 - Vegetation samples taken from the southwest corner of the west nitrate pond indicate 2,800 dpm/kg (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1964, "MONTHLY PROGRESS REPORT - SITE SURVEY - JULY 1964," INTERNAL LETTER TO C.W. PILTINGSRUD, AUGUST 5).

August 1964 - Vegetation samples taken from the northeast corner of the east nitrate pond indicate 4,500 dpm/kg (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1964, "MONTHLY PROGRESS REPORT - SITE SURVEY - AUGUST 1964," INTERNAL LETTER TO C.W. PILTINGSRUD, SEPTEMBER 8).

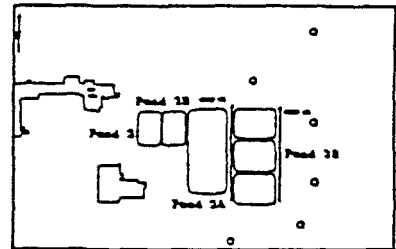
September 1964 - A pilot plant evaporator was placed on-line. Trial runs using domestic water were conducted, to be followed by trial runs using Pond 2A water (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - SEPTEMBER 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, OCTOBER 26). Vegetation samples indicated 180 dpm/kg at the southwest corner of the west nitrate pond, and 1,000 dpm/kg east of the south edge of the nitrate ponds (HAMMOND, S.E., DOW CHEMICAL COMPANY, 1964, "MONTHLY PROGRESS REPORT - SITE SURVEY - SEPTEMBER 1964," INTERNAL LETTER TO C.W. PILTINGSRUD, OCTOBER 12).

- October 1964 - The sides of 207B-North and Middle were patched using cold patch mastic. Wastes were being pumped to Pond 2A (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - OCTOBER 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, NOVEMBER 16). The sides of 207B-South had not yet been repaired (RYAN, E.S., DOW CHEMICAL COMPANY, 1964, "HISTORY REPORT - PROCESS WASTE DISPOSAL GROUP - NOVEMBER 1964," INTERNAL LETTER TO G.E. WHITE, DOW CHEMICAL COMPANY, DECEMBER 26).
- December 1966 - Releases of low nitrate treated wastes from Building 774 were impounded in the asphalt-lined evaporation ponds so that effluent from Building 995 could be used to dilute the nitrates (RYAN, E.S., DOW CHEMICAL COMPANY, 1967, "STATUS REPORT - WASTE DISPOSAL COORDINATION - DECEMBER 1966," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, JANUARY 10).
- November 1967 - Twenty-five thousand gallons of waste were taken from Pond 2A and disposed of in the evaporator. Pond 207B-North was repaired, and was expected to be in service in December (MAAS, M.E., DOW CHEMICAL COMPANY, 1967, "PROGRESS REPORT FOR NOVEMBER," INTERNAL LETTER TO K.V. BEST, DOW CHEMICAL COMPANY, NOVEMBER 27).
- 1968 - 1970 - Lithium scrap was disposed of on the dikes between the evaporation ponds by spraying it with water.
- February 1968 - A Fire Department pumper truck was used to spread 250 pounds of "Nigrosine 12525 Acid Black 2" dye into Ponds 2A and 2B in an attempt to increase the evaporation rates. An extra 250 pounds were reserved for later use (MAAS, M.E., DOW CHEMICAL COMPANY, 1968, "PROGRESS REPORT FOR FEBRUARY," INTERNAL LETTER TO K.V. BEST, DOW CHEMICAL COMPANY, FEBRUARY 27).
- April 1968 - All wastes were transferred to Pond 207B. Pond 2A was dormant (MAAS, M.E., DOW CHEMICAL COMPANY, 1968, "PROGRESS REPORT FOR FEBRUARY," INTERNAL LETTER TO K.V. BEST, DOW CHEMICAL COMPANY, FEBRUARY 27).
- October 1968 - Repairs were made to cracked side walls in 207B-Center with burlap and asphalt. An additional coat of asphalt was also applied to 207B-North (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).
- January 1969 - Low-level contamination and salts were blown out and to the east of the solar ponds by high winds (PILTINGSRUD, C.W., 1969, "STATUS REPORT - HEALTH PHYSICS - JANUARY 1969," FEBRUARY 12).
- June 1969 - Leakage appeared on the ground surface at the northeast corner of Pond 2B, possibly due to a previous leak in the north and center sections of the pond, which was repaired in 1967(?) . Plans were made to transfer the contents of 207B-North and Center to Pond 2A and repair the north and center sections (MAAS, M.E., DOW CHEMICAL COMPANY, 1969, "MONTHLY PROGRESS REPORT - WASTE TREATMENT - JUNE," INTERNAL LETTER TO L.F. GRILL, DOW CHEMICAL COMPANY, JULY 3).
- August 1969 - Pond 207B-North was emptied. Burlap was placed in uncovered areas and a coat of asphalt was applied. Another coat of asphalt was to be applied to old and new burlap surfaces by the following month, at which time 207B-North would be returned to service and 207B-Center would be repaired (MAAS, M.E., DOW CHEMICAL COMPANY, 1969, "MONTHLY PROGRESS REPORT - WASTE TREATMENT - AUGUST," INTERNAL LETTER TO L.F. GRILL, DOW CHEMICAL COMPANY, SEPTEMBER 4).

September 1969 - A second coat of asphalt was applied to 207B-North, completing repair. The contents of 207B-Center were transferred to the north section and then to Pond 2A. Burlap and a coat of asphalt were placed in the center section, and a second coat was to be applied the following month (MAAS, M.E., DOW CHEMICAL COMPANY, 1969, "MONTHLY PROGRESS REPORT - WASTE TREATMENT - SEPTEMBER," INTERNAL LETTER TO L.F. GRILL, DOW CHEMICAL COMPANY, OCTOBER 7).

April 1970 - Catch sumps and pumps were installed to return water from the drain tiles to the ponds. Sump No. 1, located at the north end of the drainage tile east of 207B, returned water to 207B-North. Sump No. 2, located at the north end of the drainage tile between Ponds 207A and 207B, returned water to 207A (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

May 1970 - A soaker hose and pump were installed at the east berm of Pond 207A as an attempt to increase evaporation rates. The new installations would allow water to trickle over the berm. Construction of Pond 207C, a new asphalt-lined pond, began. The pond was to be used to store liquids during repair of the existing ponds (MAAS, M.E., DOW CHEMICAL COMPANY, 1970, "MONTHLY PROGRESS REPORT - WASTE TREATMENT - MAY," INTERNAL LETTER TO L.F. GRILL, DOW CHEMICAL COMPANY, JUNE 10).



June 1970 - Pond 207B-South was emptied for relining (MAAS, M.E., DOW CHEMICAL COMPANY, 1970, "BUILDING 774 - JUNE, JULY PROGRESS REPORT," AUGUST 5). Pond 207C was under construction west of Pond 207A. The "small south nitrate pond" was leaking and thought to be the cause of high nitrate concentrations in North Walnut Creek (FREIBERG, K.J., DOW CHEMICAL COMPANY, 1970, "HEALTH PHYSICS MONTHLY STATUS REPORT - OPERATIONS GROUP TECHNICAL AND CONSTRUCTION - JUNE 1970," INTERNAL LETTER TO E.A. PUTZIER, JULY 9).

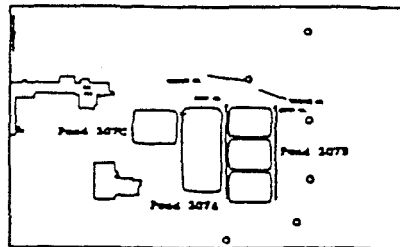
August 1970 - A program to eliminate the use of the solar evaporation ponds was initiated and submitted to AEC (FREIBERG, K.J., DOW CHEMICAL COMPANY, 1970, "HEALTH PHYSICS MONTHLY STATUS REPORT - OPERATIONS GROUP TECHNICAL AND CONSTRUCTION - AUGUST 1970," INTERNAL LETTER TO E.A. PUTZIER, SEPTEMBER 9).

September 1970 - All side walls of Pond 207B-South had been covered with burlap and asphalt (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Paving and earthwork at Pond 207C was completed. Groundwater was seeping into the sump, and this problem was to be resolved prior to sealing the area. Sludge was expected to be removed using liquid from existing ponds to create a slurry which could be pumped, rather than direct removal (FREIBERG, K.J., DOW CHEMICAL COMPANY, 1970, "HEALTH PHYSICS MONTHLY STATUS REPORT - OPERATIONS GROUP TECHNICAL AND CONSTRUCTION - SEPTEMBER 1970," INTERNAL LETTER TO E.A. PUTZIER, DOW CHEMICAL COMPANY, OCTOBER 8).

December 1970 - Pond 207C was placed in service (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

May 1971 - Test holes were dug and water samples were taken at the location of Trenches 1 and 2 (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Sediment samples taken from 207B indicated up to 10,000 dpm/g uranium and up to 140,000 dpm/g plutonium (PILTINGSRUD, C.W.,

1971, "STATUS REPORT - HEALTH PHYSICS - MAY 1971," INTERNAL LETTER TO W.H. LEE, JUNE 10). Direct readings indicated 25,000 cpm. Work using a bulldozer to remove the silt was planned for the area (FREIBERG, K.J., DOW CHEMICAL COMPANY, 1971, "HEALTH PHYSICS MONTHLY STATUS REPORT - OPERATIONS GROUP TECHNICAL AND CONSTRUCTION - MAY 1971," INTERNAL LETTER TO E.A. PUTZIER, JUNE 9).



August 1971 - Soaker hoses were installed around the perimeter of Ponds 207A and 207C (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Sludge removal operations were occurring at the evaporation ponds (specific pond not indicated) (PILTINGSRUD, C.W., 1971, "STATUS REPORT - HEALTH PHYSICS - JULY 1971," INTERNAL LETTER TO J.F. WILLGING, AUGUST 10).

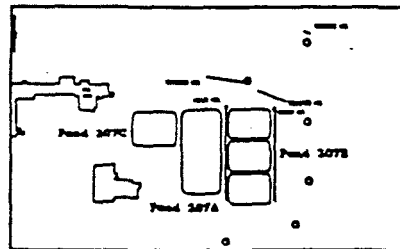
October 1971 - All side walls of Ponds 207B-North and Center were covered with Petromat liner and a hydraulic sealant. Catch Trenches 1 and 2 were dug (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Liquid collected in Trenches 1 and 2 went to Sumps 1 and 2, and then to Ponds 207B-North and 207A, respectively (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).

November 1971 - Pond 207B-South was being cleaned (PUTZIER, E.A., 1971, "STATUS REPORT - HEALTH PHYSICS OPERATIONS - OCTOBER 1971," INTERNAL LETTER TO J.F. WILLGING, NOVEMBER 5).

December 1971 - Cleaning of Pond 207B-South continued (PILTINGSRUD, C.W., 1972, "STATUS REPORT - HEALTH PHYSICS INPUT TO OPERATIONS - DECEMBER 1971," INTERNAL LETTER TO J.F. WILLGING, JANUARY 7).

May 1972 - Automatic pump controls were installed in Trenches 1 and 2 (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

September 1972 - Trench 3 was placed in service (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Liquid collected in Trench 3 was transferred to Pond 207A (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).



October 1972 - The side walls and bottom of Pond 207B-South were relined with Petromat and a hydraulic sealant (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

January 1973 - The "nitrate capture trenches located on the hillside north of the process waste holding ponds" were in operation. Water from the trenches was being analyzed and returned to the ponds. Three trenches existed at this time (MAAS, M.E. AND D.E. MICHELS, 1973, "MONTHLY ENVIRONMENTAL PROGRESS REPORT - REMOVAL OF NITRATE FROM SOIL," FEBRUARY 7).

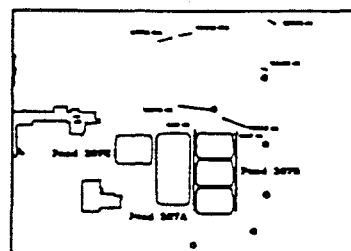


April 1973 - Six to ten tons of nitrate leached from the soils north of the evaporation ponds due to high water flows (MAAS, M.E. AND D.E. MICHELS, 1973, "MONTHLY ENVIRONMENTAL PROGRESS REPORT - REMOVAL OF NITRATE FROM SOIL," MAY?).

May 1973 - The trench pumps were turned off because of overloading of the evaporation ponds due to rain (MAAS, M.E. AND D.E. MICHELS, 1973, "MONTHLY ENVIRONMENTAL PROGRESS REPORT - REMOVAL OF NITRATE FROM SOIL," JUNE?).

September 1973 - The side walls and bottom of Pond 207B-North were relined with Petromat and a hydraulic sealant (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10).

April 1974 - Trenches 4 and 5 were placed in service (OWEN, J.B., DOW CHEMICAL COMPANY, 1974, "HISTORY OF 207 SOLAR EVAPORATION PONDS AND NITRATE IN WALNUT CREEK," LETTER TO E.W. BEAN, RFAO, USAEC, APRIL 10). Liquid collected in Trench 5 was transferred to Trench 4, and liquid collected in Trench 4 was transferred to Trench 3 (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).



June 1974 - The Petromat liner of Pond 207B-North was considered to be a problem. Actions were being taken to reline the pond bottom with asphalt concrete three inches thick. A pond leakage study was conducted using Rhodamine WT dye (THOMPSON, M.A., 1974, "PROGRESS REPORT FOR JUNE 1974 - ENVIRONMENTAL SCIENCES AND WASTE CONTROL," INTERNAL LETTER TO H.E. BOWMAN, JULY 12).

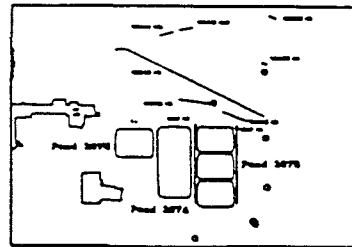
July 1974 - Trench 6 was placed in service. Liquid collected in the trench was transferred to Pond 207A (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1). LIQUID COLLECTED IN THE TRENCH WAS TRANSFERRED TO POND 207A ("EVAPORATOR NOTES & PONDS RECORD," 1978, HANDWRITTEN LOGBOOK, ENTRY OF JULY 8. ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1). Also completed in July was a study to provide for 100% recycle of RFP waters, this study recommended the use of the 207A and 207B solar ponds for storage of water treated through the reverse osmosis system and for storage of treated sanitary effluent awaiting treatment in the reverse osmosis system (ENGINEERING SCIENCE, INC., 1974, AN ENGINEERING STUDY FOR WATER CONTROL AND RECYCLE, PREPARED FOR THE ROCKY FLATS AREA OFFICE OF THE U.S. ATOMIC ENERGY COMMISSION, JULY 21). Future activities related to clean-out and relining of the 207B solar ponds were partly in support of this water recycle project. Following the publishing of this study, once a 207B solar pond was cleaned-out, no further process wastes were placed in the ponds.

September 1974 - An in-depth study including core drilling and soil analysis was initiated. An inventory and maps of nitrate deposits were to be prepared (ILLSLEY, C.T., 1974, "MONTHLY ENVIRONMENTAL PROGRESS REPORT," REPORT FOR SEPTEMBER 1974, OCTOBER?).

October 1974 - An inventory of nitrate deposits northeast of the ponds was in progress (ILLSLEY, C.T., 1974, "MONTHLY ENVIRONMENTAL PROGRESS REPORT," REPORT FOR OCTOBER 1974, NOVEMBER?).

November 1974 - A report of the nitrate inventory in the soil north of the ponds was written (ILLSLEY, C.T., 1974, "MONTHLY ENVIRONMENTAL PROGRESS REPORT," REPORT FOR NOVEMBER 1974, DECEMBER?).

March 1975 - Low level alpha contamination was detected around the perimeter of the solar ponds. It was believed to be caused by the operation of the soaker hose system on the berm of Pond 207A. Soil contamination was also detected on the downwind side of Pond 207A (THOMPSON, M.A., 1975, "PROGRESS REPORT FOR MARCH 1975 - ENVIRONMENTAL SCIENCES AND WASTE CONTROL," INTERNAL LETTER TO H.E. BOWMAN, APRIL 10).



September 1975 - Cleanout and repair of Pond 207B-North was completed (KITTINGER, W.D., ROCKWELL INTERNATIONAL, 1975, "RADIATION MONITORING - MONTHLY REPORT - SEPTEMBER, 1975," INTERNAL LETTER TO E.A. PUTZIER, ROCKWELL INTERNATIONAL, OCTOBER 10).

April 1976 - Core samples were taken from the solar ponds for the water recycle project (results of the samples were not indicated) (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL CONTROL WEEKLY HIGHLIGHTS WEEK ENDING APRIL 9, 1976," INTERNAL LETTER TO M.A. THOMPSON, ROCKWELL INTERNATIONAL, APRIL 9).

September 1976 - (This may have been in late August 1976.) An unsuccessful trial run was conducted on cleanup of 207B. Contamination was found on and under the liner and in nearby soil. It was thought that an environmental enclosure would be necessary for cleanup activities (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING SEPTEMBER 3, 1976," INTERNAL LETTER TO M.A. THOMPSON, ROCKWELL INTERNATIONAL, SEPTEMBER 3). Air monitoring during solar pond cleanup indicated between 0.00102 and 0.17136 pCi/m<sup>3</sup> plutonium concentration (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 8, 1976," INTERNAL LETTER TO ENVIRONMENTAL SCIENCES, OCTOBER 8).

October 1976 - Eleven core samples were taken from the solar pond area in preparation for the reverse osmosis holding ponds (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 22, 1976," INTERNAL LETTER TO ENVIRONMENTAL SCIENCES, OCTOBER 22). Fifteen soil samples were also taken during the month to determine contamination levels (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 29, 1976," INTERNAL LETTER TO ENVIRONMENTAL SCIENCES, OCTOBER 29). Air samples taken during solar pond cleanup during the first half of the month indicated plutonium concentrations ranging from 0.00395 to 0.86791 pCi/m<sup>3</sup> (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING NOVEMBER 5, 1976," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, NOVEMBER 5).

November 1976 - A "crash program" of sampling and direct counting was initiated, providing aid for the completion of the design criteria for the project. The program consisted of coring through the liner and augering into the deeper soil (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1976, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING NOVEMBER 5, 1976," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, NOVEMBER 5).

February 1977 - The liner of 207B-North was damaged by high winds, resulting in increased airborne total long-lived alpha concentrations. Water was put in the pond to keep the liner in place (HORNBAKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING FEBRUARY 4, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, FEBRUARY 4). The southeast perimeter of 207C was sandbagged to prevent spillage due to high winds. The liner of 207B-North was weighted down with steel pallets to prevent floatation

(HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING FEBRUARY 18, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, FEBRUARY 18; HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING FEBRUARY 25, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, FEBRUARY 25).

March 1977 - A recommendation for disposal of 50 liters of toluene containing 20 microcuries of tritium into Pond 207A was made (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL HIGHLIGHTS - WEEK ENDING APRIL 1, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, APRIL 1).

June 1977 - Gravel removal at the solar pond area began. (This may have begun in late May 1977.) Survey of the area during removal operations indicated a high reading of 15,000 cpm (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING JUNE 3, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JUNE 3). A map indicating contamination levels in the vicinity of the solar ponds was prepared (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING JUNE 10, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JUNE 10). Soil removal operations were conducted in the 910 storage yard and along the fence between the solar ponds and the yard using a portable building for manual removal, or a front end loader with a dust suppressant. Air sampling during the activities indicated 0.005 to approximately 0.3 pCi/m<sup>3</sup>. Construction of the reverse osmosis building began during this month (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING JUNE 24, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JUNE 24).

July 1977 - Soil was removed from an area south of Pond 207A using a road grader and front end loader (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING JULY 29, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JULY 29).

August 1977 - Activities at Pond 207B-South included water removal, cleaning, and sludge removal. The pallets which had been placed at Pond 207B-North were removed, and cleaning also began at the pond (AUTHOR UNKNOWN, 1977, "POND CLEAN-UP OPERATIONS," CHRONOLOGY OF POND CLEAN-UP ACTIVITIES FROM AUGUST 17, 1977 TO SEPTEMBER 2, 1977, DATE UNKNOWN).

September 1977 - (This may have been in late August.) An increase in airborne alpha activity was reported during soil removal activities at the solar ponds (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING SEPTEMBER 2, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, SEPTEMBER 2). Air monitoring on September 19 indicated 0.095 pCi/m<sup>3</sup> total long-lived alpha (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING SEPTEMBER 23, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, SEPTEMBER 23). Near the end of the month, air sampling results exceeded the shutdown action level. Cleanup of 207B-North was completed (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING SEPTEMBER 30, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, SEPTEMBER 30). The water and liner were removed from Pond 207B-North, and cleaning of the pond continued (AUTHOR UNKNOWN, 1977, "POND CLEAN-UP OPERATIONS," CHRONOLOGY OF POND CLEAN-UP ACTIVITIES FROM AUGUST 17, 1977 TO SEPTEMBER 2, 1977, DATE UNKNOWN).

October 1977 - The highest total long-lived alpha concentration since cleanup activities began, 0.951 pCi/m<sup>3</sup>, was measured near a shipping box which was being loaded with soil (HORNBACKER, D.D.,

ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 7, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, OCTOBER 7). Removal of soil between Ponds 207A and 207B was completed. Removal of soil south of 207B began (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 17, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, OCTOBER 17). High results during air monitoring were again a problem. Sprinkling over a longer period of time, rather than flooding the area, was recommended, as well as the use of CohereX stabilizer (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1977, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING OCTOBER 21, 1977," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, OCTOBER 21).

March 1978 - Alternate uses of water from the reverse osmosis building and sewage treatment plant were being considered. A proposal for a new pond on the west side of the plant was rejected. The use of spray irrigation was being evaluated (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1978, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING MARCH 23, 1978," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, MARCH 23).

May 1978 - Asphalt from Pond 207B was being removed and boxed. High airborne total long-lived alpha activity was an ongoing problem (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1978, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING MAY 26, 1978," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, MAY 26).

July 1978 - Residual uranium and americium were found in the equalizer between Ponds 207B-Center and 207B-South. The line was cleaned with acid (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1978, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING JULY 28, 1978," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JULY 28).

August 1978 - Lining of Pond 207B-South was near completion (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1978, "ENVIRONMENTAL ANALYSIS AND CONTROL WEEKLY HIGHLIGHTS WEEK ENDING AUGUST 4, 1978," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, AUGUST 4).

January 1979 - Plutonium values of 5.8 to 12.6 pCi/l were detected in Pond 207B-North. This was due to the transfer of sodium hydroxide spillwater from Pond B-1 to Pond 207B-North (BARKER, C.J., ROCKWELL INTERNATIONAL, 1979, "HIGHLIGHTS FOR WEEK ENDING JANUARY 19, 1979 ENVIRONMENTAL ANALYSIS AND CONTROL," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, JANUARY 19).

April 1979 - Release of the caustic spill water in Pond 207B-North into Pond B-2 and A-2 began (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1979, "HIGHLIGHTS FOR WEEK ENDING APRIL 27, 1979 ENVIRONMENTAL ANALYSIS AND CONTROL," INTERNAL LETTER TO M.V. WERKEMA, ROCKWELL INTERNATIONAL, APRIL 27). Plans to run the spill water through the reverse osmosis plant or process it through the sewage treatment plant were not implemented.

May 1980 - Water bubbles appeared under the liner of Pond 207B-South (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1980, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING MAY 16, 1980," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, MAY 16). The pond had been used for storage of sanitary water prior to reverse osmosis treatment, but was drained and cleaned for storage of reverse osmosis treated water for use in the plant's cooling towers. A survey of the liner indicated no smear count, but 50,000 to 500,000 cpm on the west side wall behind the liner, possibly resulting from leakage from Pond 207A. The discovery of leakage delayed approval of use of the water in the plant's cooling towers for fear of contamination (HORNBACKER, D.D.,

ROCKWELL INTERNATIONAL, 1980, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING MAY 30, 1980," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, MAY 30).

June 1980 - The source of activity beneath the liner on the west wall of Pond 207B-South was determined to be americium (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1980, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING JUNE 6, 1980," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, JUNE 6).

July 1980 - Salts on the side walls of Pond 207A, resulting from evaporation, had a count of 50,000 cpm (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1980, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING AUGUST 1, 1980," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, AUGUST 1).

September 1980 - Cleanout of Pond 207B-Center began with removal of sand, sludge, tar and debris. Sludge was moved to the northwest corner of the pond for transfer to Pond 207A. Air monitoring prior to the start of cleanup activities indicated 0.06 pCi/m<sup>3</sup> total long-lived alpha (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1980, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING SEPTEMBER 12, 1980," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, SEPTEMBER 12).

April 1981 - The french drain system, located on the hillside north of the ponds, was placed in service. The 6 trenches and 2 sumps were taken out of service. Liquid collected in the drain system would go to the Interceptor Trench Pump House (ITPH) and then be transferred to Pond 207B-North. Periodically, the liquid would be transferred from Pond 207B-North to Ponds 207B-Center and South (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).

July 1981 - Isolated spots of contaminated soil were removed from the berm east of the 207 ponds by hand digging. Soil removal on the east side of the berm was complete. The north side of the berm would be worked on next (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1981, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING JULY 24, 1981," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, JULY 24).

November 1981 - Approximately 1,000 gallons of sewage sludge slurry from the digester and aerator were placed in Pond 207A after a tank truck spilled the material on the ground near the pond. The sewage was pumped from the ground into the pond (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1981, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING NOVEMBER 25, 1981," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, NOVEMBER 30).

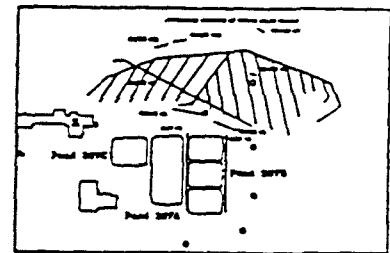
January 1982 - A potential nitrate runoff problem resulting from the hillside seepage below the solar ponds was of concern. Plans were made to construct a collection trench and sump at the base of the hill (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING JANUARY 8, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, JANUARY 8).

February 1982 - Plans were made to pump high-nitrate water from Pond A-3 to Pond 207B (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING FEBRUARY 19, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, FEBRUARY 19).

April 1982 - (This may have occurred in late February.) Construction activities to expand the nitrate collection system on the south side of the PSZ patrol road began (HORNACHER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING APRIL 2, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, APRIL 2). Spraying of water from 207B-North was

conducted at a rate of approximately 89,445 gallons per acre (HORNBACKER, 445 GALLONS PER ACRE. (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING APRIL 23, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, APRIL 23). Note: the area where this spraying was taking place is now known as the West Spray Field, Operable Unit 11. Water for application to the West Spray Field was removed from Solar Ponds 207B-Center and 207B-North. During the time of West Spray Field Operation, Solar Pond 207B-Center contained treated sanitary effluent, while Solar Pond 207B-North contained water collected in the ITPH system (ADVANCED SCIENCES, INC., 1991, "SOLAR POND INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY, ROCKY FLATS PLANT," TASK 7 OF THE ZERO-OFFSITE WATER-DISCHARGE STUDY, PREPARED FOR EG&G ROCKY FLATS, INC., JANUARY 8).

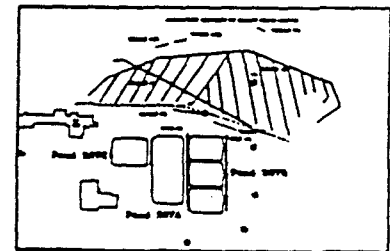
May 1982 - The new nitrate collection system near the northeast security road was reported to be operating properly (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING MAY 7, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, MAY 7).



July 1982 - Nitrate concentrations in the solar ponds were as follows: 310 mg/l for Pond 207B-North on July 6; 158 mg/l for 207B-North on July 12; and 250 mg/l for 207B-Center on July 12 (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING JULY 16, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, JULY 16). The valve between 207B-North and Center was repaired to prevent the accidental spraying of water from 207B-North (HORNBACKER, D.D., ROCKWELL INTERNATIONAL, 1982, "ENVIRONMENTAL ANALYSIS WEEKLY HIGHLIGHTS WEEK ENDING JULY 23, 1982," INTERNAL LETTER TO T.R. CRITES, ROCKWELL INTERNATIONAL, JULY 23).

November 1985 - Use of the West Spray Field ended (ADVANCED SCIENCES, INC., 1991, "SOLAR POND INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY, ROCKY FLATS PLANT," TASK 7 OF THE ZERO-OFFSITE WATER-DISCHARGE STUDY, PREPARED FOR EG&G ROCKY FLATS, INC., JANUARY 8).

October 1986 - Construction of the new pondcreting building was complete (ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).



May 1988 - First spill of pondcrete occurred. This spill occurred on the 904 Pad (ROCKY FLATS PLANT, 1988, "RCRA CONTINGENCY PLAN IMPLEMENTATION REPORT NO. 88-001, ROCKY FLATS PLANT, EPA ID NUMBER CO 7890010526," JUNE 7). Other spills of pondcrete occurred after this first spill.

June/July 1988 - Last process waste sludge and water removed from Solar Pond 207A (BLAHA, F.J., ROCKWELL INTERNATIONAL CORPORATION, 1988, INTERNAL MEMORANDUM FROM F.J. BLAHA TO G. HEWITT, JUNE 23; ROCKWELL INTERNATIONAL, 1988, "SOLAR EVAPORATION PONDS CLOSURE PLAN," JULY 1).

August 1989 - The Solar Pond's Interceptor Trench Central Collection Sump Pit overflowed. The water which flowed out of the pit was not recovered, and the water that remained in the pit was pumped to Pond 207B-North. The amount of liquid released to the environment was unknown (U.S. DEPARTMENT OF ENERGY, 1989, "RCRA CONTINGENCY PLAN IMPLEMENTATION REPORT NO. 89-012," DATE UNKNOWN).

March 1990 - Levels of established freeboard were exceeded in the 207B Ponds. These levels were set to prevent overflow caused by high winds. No release to the environment occurred. To lower the water level in the 207B Ponds, transfer of approximately 1.3 million gallons was made to Pond 207A. The excess water in Pond 207A was then to be transferred to Building 374 for evaporation (U.S. DEPARTMENT OF ENERGY, 1990, "RCRA CONTINGENCY PLAN IMPLEMENTATION REPORT No. 90-003," DATE UNKNOWN).

September 1990 - Some seepage, which was not collected by the ITPH because of soil blocking the gravel and disallowing collection of the material, flowed over the eastern extension of the ITPH (EG&G ROCKY FLATS, 1991, "SOLAR PONDS INTERCEPTOR TRENCH SYSTEM GROUNDWATER MANAGEMENT STUDY ROCKY FLATS PLANT SITE," JANUARY 15).

September 1992 - Only limited quantities of water and sediments are present in Pond 207A, all other ponds have considerable quantities of water present.

Note: Add in information regarding SEP IM/IRA Activities  
End 1989/begin of 1990 - construction of sprung structures

**APPENDIX D**  
**EG&G FORMS**



## EQUIPMENT DECONTAMINATION/WASH CHECKLIST AND RECORD

## I. General Information completed by: \_\_\_\_\_

Name

Date

Phone No.

\_\_\_\_\_  
Subcontractor's Name

NOTE: Sections I and II will be completed by the same individual.

Equipment Manufacturer, Model and Common Name: \_\_\_\_\_

Equipment Owner: \_\_\_\_\_

Name and Phone Number of Person Responsible for the Equipment: \_\_\_\_\_

Serial Number/Equipment Identification Number: \_\_\_\_\_

Delivered to Decontamination Station by: \_\_\_\_\_

Initial contaminate characterization of work area: (check one)

Not potentially contaminated \_\_\_\_\_

Potentially contaminated \_\_\_\_\_

## II. Activity History

Where was equipment used? \_\_\_\_\_

What was equipment used for? \_\_\_\_\_

Types and volumes of water generated: (check as appropriate)

\_\_\_\_\_ Purge \_\_\_\_\_ Gallons

\_\_\_\_\_ Development \_\_\_\_\_ Gallons

\_\_\_\_\_ Decon/Wash \_\_\_\_\_ Gallons

\_\_\_\_\_ Rinse \_\_\_\_\_ Gallons

## EQUIPMENT DECONTAMINATION/WASH CHECKLIST AND RECORD

## III. Actions At Central Decontamination Station

Yes	No	
_____	_____	The equipment was washed under the provisions of SOP No. FO3, General Equipment Decontamination
_____	_____	Personnel Decontamination Station established as described in the applicable site-specific health and safety plan
_____	_____	Personal protective equipment (PPE) selected based upon work area PPE level
_____	_____	Specify PPE level utilized: _____ Level B _____ Level C _____ Level D
_____	_____	PPE inspected prior to donning
_____	_____	Wind direction checked prior to using pressurized spray (circle the direction the wind was blowing from) N NE E SE S SW W NW
_____	_____	Was particular attention devoted to equipment parts that contacted potentially contaminated medium?
_____	_____	Was personal decontamination completed as described in the applicable site-specific health and safety plan?



## FIELD MONITORING RESULTS

1. Project Location: \_\_\_\_\_ Site Number: \_\_\_\_\_ Date: \_\_\_\_\_

#### 4. SAMPLE MEASUREMENTS (Continued)

[illegible]

\* If any OVD or RAD measurements are above background measurements, forms FO.8A and/or FO.16A must be completed for verification

Completed By: \_\_\_\_\_

Subcontractor: \_\_\_\_\_

## VERIFICATION OF ORGANIC VAPOR MONITORING RESULTS

1. Project Name &amp; Number: \_\_\_\_\_

Date: \_\_\_\_\_ Site Number: \_\_\_\_\_

2. Historical Characterization (check one):

☐ Not potentially contaminated ☐ Low-Level RAD ☐ Hazardous ☐ Mixed

3. Prework/Background Organic Vapor Monitoring Results

Instrument Used: \_\_\_\_\_ Serial No. \_\_\_\_\_

(Numeric Value): \_\_\_\_\_ (Units, i.e., ppm): \_\_\_\_\_

4. Verification Measurements

Time	Depth (Ft)	Initial Reading (ppm)	First Background Check (ppm)	First Verification Reading (ppm)	Second Background Check (ppm)	Second Verification Reading (ppm)

5. If either of the verification measurements are above the preceding background measurement, the initial measurement has been verified.

Completed By: \_\_\_\_\_  
Print Name Signature Date

Subcontractor: \_\_\_\_\_

1. Project Name & Number: \_\_\_\_\_

Site Number: \_\_\_\_\_

- |       |                          |       |                              |
|-------|--------------------------|-------|------------------------------|
| _____ | Low-Level RAD Substances | _____ | Hazardous Substances         |
| _____ | Mixed Substances         | _____ | Not Potentially Contaminated |

- No                      Yes (check as appropriate)

\_\_\_\_\_ Low-Level RAD Substances      \_\_\_\_\_ Hazardous Substances      \_\_\_\_\_ Mixed Substances

- Organic Vapors: \_\_\_\_\_ (Instrument Used)

Radioisotopes: \_\_\_\_\_ (Instrument Used)

[illegible]

Completed By: \_\_\_\_\_

Print Name	Signature	Date
------------	-----------	------

Subcontractor: \_\_\_\_\_

Project Name: \_\_\_\_\_

Date: \_\_\_\_\_ Site Number: \_\_\_\_\_

Snow Cover Present (Y/N): \_\_\_\_\_ Work Surface Wet (Y/N): \_\_\_\_\_

Manufacturer and Model No.	Serial Number	Probe Type	Probe Serial No.	Calibration Due Date	Background Reading (cpm)

\_\_\_\_\_ cpm at Point of Intrusive Activity      \_\_\_\_\_ Highest Measured cpm

[illegible]

Completed By: \_\_\_\_\_

Print Name	Signature	Date
------------	-----------	------

Subcontractor: \_\_\_\_\_

## RESULTS OF RADIOLOGICAL MEASUREMENTS IN THE FIELD

Project Name: \_\_\_\_\_

Date: \_\_\_\_\_ Site Number: \_\_\_\_\_

Snow Cover Present (Y/N): \_\_\_\_\_

## 1. Instruments Used and Background Readings

Manufacturer and Model No.	Serial Number	Probe Type	Probe Serial No.	Calibration Due Date	Background Reading (cpm)

## 2. PPE Monitoring

\_\_\_\_\_ PPE monitoring not required. Work area was characterized as uncontaminated and field radiological screening as work progressed did not indicate the presence of potential contamination.

If PPE monitoring required complete the following table

Ludlum Model 12	Bicron Analyst Fidler	PPE screening resulted in verived positive reading (Y/N)	Time	PPE Verified positive reading (cmp)	Smear No.

Completed By: \_\_\_\_\_  
Print Name Signature Date

Subcontractor: \_\_\_\_\_



**APPENDIX E**

**SUMMARY OF LIQUID, SLUDGE, AND SOIL DATA  
FROM OPERABLE UNIT 4**

**TABLE 2.7**  
**SOLAR EVAPORATION POND 207A**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**

Compound	Units	207A Liquid		207A Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
ANIONS					
Ammonia	ppm	NA	0.43	NA	NA
Bicarbonate	ppm	NA	35	NA	NA
Carbonate	ppm	NA	47	NA	NA
Chloride	ppm	NA	416	NA	NA
Cyanide, Total	ppm	ND - 1.7	0.478	NA	NA
Fluoride	ppm	NA	ND	NA	NA
Nitrate, N	ppm	ND - 21,739	1000	8800	NA
Nitrite	ppm	NA	39	NA	NA
Phosphate, Ortho	ppm	NA	ND	NA	NA
Phosphate, Total	ppm	NA	ND	NA	NA
Sulfate	ppm	NA	409	NA	NA
Sulfide	ppm	NA	ND	NA	NA
TKN-N	ppm	NA	ND	NA	NA
RADIONUCLIDES					
Americium -241	pCi/l	ND - 200	0.42	NA	NA
Americium -241	pCi/g	NA	NA	1400-4400	1.5
Plutonium -239	pCi/l	ND - 660	0.71	ND	NA
Plutonium -239	pCi/g	NA	NA	1000-3700	7.2
Uranium -234	pCi/l	14000-20000	310	NA	NA
Uranium -234	pCi/g	NA	NA	70-570	95
Uranium -235	pCi/l	NA	11	28-28	NA
Uranium -235	pCi/g	NA	NA	28-28	2.9
Uranium -238	pCi/l	21000-28000	340	520-520	NA
Uranium -238	pCi/g	NA	NA	130-480	93

TABLE 2.7

SOLAR EVAPORATION POND 207A  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207A Liquid		207A Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Uranium	pCi/l	0.7-26000	ND	NA	NA
Tritium	pCi/l	240-3000	NA	NA	NA
Tritium	pCi/g	NA	NA	1300-12000	NA
Gross Alpha	pCi/l	32-80000	300	NA	NA
Gross Alpha	pCi/g	NA	NA	NA	5100
Gross Beta	pCi/l	2-40000	930	NA	NA
Gross Beta	pCi/g	NA	NA	NA	1400
MISCELLANEOUS TESTS					
Alkalinity, Total	ppm	NA	110	NA	NA
Conductivity @ 25C	uMHOs	NA	8800	NA	NA
Total Dissolved Solids	ppm	127000-127000	7600	NA	NA
Total Organic Carbon	ppm	NA	67.8	NA	NA
Total Suspended Solids	%	NA	23	NA	NA
pH	ppm	8.3-11	9.9	9.5	NA
METALS					
Aluminum	ppm	2.31-2.64	ND	11000-11900	NA
Antimony	ppm	NA	ND	NA	NA
Arsenic	ppm	0.015-0.015	ND	ND	NA
Barium	ppm	ND	NA	ND	NA
Beryllium	ppm	ND-0.1	NA	309-1570	NA
Bismuth	ppm	NA	ND	NA	NA
Boron	ppm	NA	1.26	NA	NA
Cadmium	ppm	0.070-0.150	ND	1110-10500	NA
Calcium	ppm	ND	60.4	19600-50000	NA
Cerium	ppm	NA	NA	NA	NA
Cesium	ppm	NA	NA	NA	NA

TABLE 2.7

SOLAR EVAPORATION POND 207A  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207A Liquid		207A Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Cobalt	ppm	0.200-0.500	NA	ND	NA
Chromium, Total	ppm	13.7-16.7	ND	1010-19700	NA
Chromium, Hexavalent	ppm	NA	NA	ND-1.0	NA
Copper	ppm	1.61-1.8	ND	425-1590	NA
Germanium	ppm	NA	NA	NA	NA
Iron	ppm	1.5-8.0	ND	3590-6900	NA
Lead	ppm	ND	0.004	65-455	NA
Lithium	ppm	NA	1.42	NA	NA
Magnesium	ppm	ND	121	6100-21000	NA
Manganese	ppm	0.095-0.115	ND	153-595	NA
Mercury	ppm	ND-0.0002	ND	7.5-25	NA
Molybdenum	ppm	NA	ND	NA	NA
Nickel	ppm	1.9-2.0	ND	124-1320	NA
Niobium	ppm	NA	NA	NA	NA
Phosphorous	ppm	NA	NA	NA	NA
Potassium	ppm	13200-14300	376	50000-65300	NA
Rubidium	ppm	NA	NA	NA	NA
Selenium	ppm	ND	0.015	ND	NA
Silicon	ppm	NA	0.846	NA	NA
Silver	ppm	NA	ND	153-237	NA
Sodium	ppm	36300-42900	1610	130000-166000	NA
Strontium	ppm	NA	2.35	NA	NA
Tantalum	ppm	NA	NA	NA	NA
Tellurium	ppm	NA	NA	NA	NA
Thallium	ppm	NA	ND	NA	NA
Thorium	ppm	NA	NA	NA	NA

TABLE 2.7

SOLAR EVAPORATION POND 207A  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207A Liquid		207A Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Tin	ppm	7-13	ND	ND	NA
Titanium	ppm	NA	NA	NA	NA
Tungsten	ppm	NA	NA	NA	NA
Vanadium	ppm	0.10-0.20	NA	NA	NA
Zirconium	ppm	NA	NA	NA	NA
Zinc	ppm	0.62-0.78	0.028	227-595	NA
VOLATILE ORGANICS					
Acetone	ppb	100-260	3.0	5-4680	NA
Methylene Chloride	ppb	ND	5.0	ND	NA
Tetrachloroethene	ppb	ND	ND	ND-1200	NA
SEMIVOLATILE					
Acenaphthene	ppb	NA	ND	NA	NA
Bis(2-ethylhexyl) phthalate	ppb	NA	ND	ND-14900	NA
4-Chloro-3-methylphenol	ppb	NA	ND	NA	NA
2-Chlorophenol	ppb	NA	ND	NA	NA
1,4-Dichlorobenzene	ppb	NA	ND	NA	NA
2,4-Dinitrotoluene	ppb	NA	ND	NA	NA
Di-n-butyl phthalate	ppb	NA	ND	ND-590	NA
Fluoranthene	ppb	NA	ND	161-1680	NA
N-Nitroso-di-propylamine	ppb	NA	ND	NA	NA
Phenol	ppb	NA	ND	NA	NA
Phenols, Total	ppb	13-35	NA	ND-3300	NA
Pyrene	ppb	NA	ND	NA	NA
1,2,4-Trichlorobenzene	ppb	NA	ND	NA	NA
PESTICIDES/PCBs					
Atrazine	ppb	NA	3.5	NA	NA

TABLE 2.7

SOLAR EVAPORATION POND 207A  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207A Liquid		207A Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Diazinon	ppb	NA	ND	NA	NA
Simazine	ppb	NA	ND	NA	NA

References: Rockwell International, 1988a, Solar Evaporation Ponds Closure Plan  
Dames and Moore, 1991, A Summary of Chemical Analyses of Sludge and Water

NA -- Not Analyzed  
ND -- Not Detected

**TABLE 2.8**  
**SOLAR EVAPORATION POND 207B (NORTH)**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**

Compound	Units	207B (North) Liquid		207B (North) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
ANIONS					
Ammonia	ppm	NA	ND	NA	102
Bicarbonate	ppm	NA	ND	NA	ND
Carbonate	ppm	NA	ND	NA	ND
Chloride	ppm	NA	147	NA	1910
Cyanide, Total	ppm	NA	37.8	NA	ND
Fluoride	ppm	NA	ND	NA	ND
Nitrate, N	ppm	212 - 1367	39	NA	600
Nitrite	ppm	NA	ND	NA	10
Phosphate, Ortho	ppm	NA	ND	NA	4
Phosphate, Total	ppm	NA	0.04	NA	ND
Sulfate	ppm	NA	155	NA	ND
Sulfide	ppm	NA	ND	NA	56
TKN-N	ppm	NA	ND	NA	1430
RADIONUCLIDES					
Americium -241	pCi/l	ND	0.14	NA	NA
Americium -241	pCi/g	NA	NA	NA	ND
Plutonium -239	pCi/l	ND	ND	NA	NA
Plutonium -239	pCi/g	NA	NA	NA	2.2
Uranium -234	pCi/l	50 - 53	40	NA	NA
Uranium -234	pCi/g	NA	NA	NA	13
Uranium -235	pCi/l	NA	1.7	NA	NA
Uranium -235	pCi/g	NA	NA	NA	0.4
Uranium -238	pCi/l	31 - 33	26	NA	NA
Uranium -238	pCi/g	NA	NA	NA	8.4

TABLE 2.8

**SOLAR EVAPORATION POND 207B (NORTH)**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**  
(continued)

Compound	Units	207B (North) Liquid		207B (North) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Uranium	pCi/l	NA	ND	NA	ND
Tritium	pCi/l	1200 - 1300	NA	NA	NA
Tritium	pCi/g	NA	NA	NA	NA
Gross Alpha	pCi/l	13 - 323	59	NA	
Gross Alpha	pCi/g	NA	NA	NA	33
Gross Beta	pCi/l	5 - 200	110	NA	
Gross Beta	pCi/g	NA	NA	NA	46
<b>MISCELLANEOUS TESTS</b>					
Alkalinity, Total	ppm	NA	75	NA	290
Conductivity @ 25C	uMHOs	NA	3380	NA	589
Total Dissolved Solids	ppm	NA	3200	NA	NA
Total Organic Carbon	ppm	NA	7.6	NA	11000
Total Suspended Solids	%	NA	18	NA	26
pH	ppm	7.5 - 9.6	8.5	NA	7.3
<b>METALS</b>					
Aluminum	ppm	ND - 1.00	ND	NA	4140
Antimony	ppm	ND	ND	NA	ND
Arsenic	ppm	ND	ND	NA	ND
Barium	ppm	ND - 0.22	ND	NA	NA
Beryllium	ppm	ND - 0.06	NA	NA	NA
Bismuth	ppm	ND	ND	NA	ND
Boron	ppm	0.09 - 0.31	0.173	NA	ND
Cadmium	ppm	ND - 0.01	ND	NA	12
Calcium	ppm	20 - 290	189	NA	247000
Cerium	ppm	ND	NA	NA	NA
Cesium	ppm	ND	NA	NA	NA



TABLE 2.8

SOLAR EVAPORATION POND 207B (NORTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (North) Liquid		207B (North) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Cobalt	ppm	ND	NA	NA	NA
Chromium, Total	ppm	ND	ND	NA	33
Chromium, Hexavalent	ppm	NA	NA	NA	NA
Copper	ppm	ND	ND	NA	ND
Germanium	ppm	ND	NA	NA	NA
Iron	ppm	ND - 0.29	ND	NA	4530
Lead	ppm	ND - 0.004	ND	NA	12
Lithium	ppm	0.37 - 6	0.332	NA	ND
Magnesium	ppm	66 - 120	79.3	NA	4670
Manganese	ppm	ND - 0.015	ND	NA	80
Mercury	ppm	ND	ND	NA	ND
Molybdenum	ppm	ND - 0.0069	ND	NA	ND
Nickel	ppm	ND - 0.05	ND	NA	ND
Niobium	ppm	ND	NA	NA	NA
Phosphorous	ppm	ND	NA	NA	NA
Potassium	ppm	56 - 120	58.8	NA	ND
Rubidium	ppm	ND	NA	NA	NA
Selenium	ppm	ND - 0.024	0.008	NA	ND
Silicon	ppm	ND - 5.6	1.02	NA	2670
Silver	ppm	ND - 0.082	ND	NA	ND
Sodium	ppm	363 - 820	403	NA	ND
Strontium	ppm	0.14 - 3.5	2.22	NA	692
Tantalum	ppm	ND	NA	NA	NA
Tellurium	ppm	ND	NA	NA	NA
Thallium	ppm	ND	ND	NA	7
Thorium	ppm	ND	NA	NA	NA

TABLE 2.8

SOLAR EVAPORATION POND 207B (NORTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (North) Liquid		207B (North) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Tin	ppm	ND	ND	NA	ND
Titanium	ppm	ND	NA	NA	NA
Tungsten	ppm	ND	NA	NA	NA
Vanadium	ppm	ND	NA	NA	NA
Zirconium	ppm	ND	NA	NA	NA
Zinc	ppm	ND - 0.022	0.048	NA	101
VOLATILE ORGANICS					
Acetone	ppb	ND	ND	NA	ND
Methylene Chloride	ppb	19-71	ND	NA	ND
Tetrachloroethene	ppb	ND	ND	NA	ND
SEMIVOLATILE					
Acenaphthene	ppb	NA	ND	NA	4500
Bis(2-ethyl hexyl) phthalate	ppb	NA	ND	NA	NA
4-Chloro-3-methylphenol	ppb	NA	ND	NA	7900
2-Chlorophenol	ppb	NA	ND	NA	7700
1,4-Dichlorobenzene	ppb	NA	ND	NA	4000
2,4-Dinitrotoluene	ppb	NA	ND	NA	3500
Di-nbutyl phthalate	ppb	NA	ND	NA	ND
Fluoranthene	ppb	NA	ND	NA	ND
N-Nitroso-di-propylamine	ppb	NA	ND	NA	3900
Phenol	ppb	NA	ND	NA	7400
Phenols, Total	ppb	3 - 46	NA	NA	NA
Pyrene	ppb	NA	ND	NA	4600
1,2,4-Trichlorobenzene	ppb	NA	ND	NA	4300
PESTICIDES/PCBs					

TABLE 2.8

SOLAR EVAPORATION POND 207B (NORTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (North) Liquid		207B (North) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Atrazine	ppb	NA	1.1	NA	ND
Diazinon	ppb	NA	ND	NA	ND
Simazine	ppb	NA	ND	NA	ND

References: Rockwell International, 1988a, Solar Evaporation Ponds Closure Plan  
Dames and Moore, 1991, A Summary of Chemical Analyses of Sludge and Water

NA -- Not Analyzed

ND -- Not Detected

**TABLE 2.9**  
**SOLAR EVAPORATION POND 207B (CENTER)**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**

Compound	Units	207B (Center) Liquid		207B (Center) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
ANIONS					
Ammonia	ppm	NA	0.5	NA	135
Bicarbonate	ppm	NA	ND	NA	ND
Carbonate	ppm	NA	280	NA	ND
Chloride	ppm	NA	763	NA	11200
Cyanide, Total	ppm	NA	0.555	NA	ND
Fluoride	ppm	NA	73	NA	ND
Nitrate, N	ppm	ND - 1220	1600	NA	13000
Nitrite	ppm	NA	75	NA	470
Phosphate, Ortho	ppm	NA	ND	NA	14
Phosphate, Total	ppm	NA	3.1	NA	2100
Sulfate	ppm	NA	736	NA	6950
Sulfide	ppm	NA	ND	NA	ND
TKN-N	ppm	NA	ND	NA	16700
RADIONUCLIDES					
Americium -241	pCi/l	NA	5.5	NA	ND
Americium -241	pCi/g	NA	NA	NA	NA
Plutonium -239	pCi/l	NA	0.4	NA	NA
Plutonium -239	pCi/g	NA	NA	NA	5.1
Uranium -234	pCi/l	NA	780	NA	NA
Uranium -234	pCi/g	NA	NA	NA	70
Uranium -235	pCi/l	NA	36	NA	NA
Uranium -235	pCi/g	NA	NA	NA	2.5
Uranium -238	pCi/l	NA	900	NA	NA
Uranium -238	pCi/g	NA	NA	NA	75

TABLE 2.9

**SOLAR EVAPORATION POND 207B (CENTER)**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**  
(continued)

Compound	Units	207B (Center) Liquid		207B (Center) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Uranium	pCi/l	NA	ND	NA	ND
Tritium	pCi/l	NA	NA	NA	NA
Tritium	pCi/g	NA	NA	NA	NA
Gross Alpha	pCi/l	4 - 2500	2400	NA	
Gross Alpha	pCi/g	NA	NA	NA	120
Gross Beta	pCi/l	8 - 1500	3900	NA	
Gross Beta	pCi/g	NA	NA	NA	380
<b>MISCELLANEOUS TESTS</b>					
Alkalinity, Total	ppm	NA	1000	NA	2700
Conductivity @ 25C	uMHO s	NA	1350	NA	3700
Total Dissolved Solids	ppm	NA	13000	NA	ND
Total Organic Carbon	ppm	NA	126	NA	22000
Total Suspended Solids	%	NA	15	NA	10
pH	ppm	7.3-11.3	9.1	NA	9.2
<b>METALS</b>					
Aluminum	ppm	ND - 2.00	ND	NA	2350
Antimony	ppm	ND	ND	NA	ND
Arsenic	ppm	ND	0.014	NA	ND
Barium	ppm	ND	ND	NA	ND
Beryllium	ppm	ND	ND	NA	ND
Bismuth	ppm	ND	ND	NA	ND
Boron	ppm	0.071 - 0.67	2.77	NA	ND
Cadmium	ppm	ND-0.01	ND	NA	108
Calcium	ppm	2.9- 95	22.6	NA	108000
Cerium	ppm	ND	NA	NA	NA

TABLE 2.9

SOLAR EVAPORATION POND 207B (CENTER)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (Center) Liquid		207B (Center) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Cesium	ppm	ND - 0.35	NA	NA	NA
Cobalt	ppm	ND	NA	NA	NA
Chromium, Total	ppm	ND	0.094	NA	127
Chromium, Hexavalent	ppm	NA	NA	NA	97
Copper	ppm	ND - 0.037	0.035	NA	96
Germanium	ppm	ND	NA	NA	NA
Iron	ppm	ND - 0.2	ND	NA	2650
Lead	ppm	ND - 0.002	ND	NA	13
Lithium	ppm	0.052 - 3.5	2.6	NA	ND
Magnesium	ppm	3.9 - 91	181	NA	13700
Manganese	ppm	ND - 0.022	ND	NA	208
Mercury	ppm	ND	ND	NA	2
Molybdenum	ppm	0.004 - 0.037	ND	NA	ND
Nickel	ppm	ND - 0.016	ND	NA	ND
Niobium	ppm	ND	NA	NA	NA
Phosphorous	ppm	ND - 0.2	NA	NA	NA
Potassium	ppm	30 - 110	729	NA	ND
Rubidium	ppm	ND	NA	NA	NA
Selenium	ppm	ND - 0.019	ND	NA	ND
Silicon	ppm	1.4 - 5.5	1.41	NA	2690
Silver	ppm	ND - 0.015	ND	NA	ND
Sodium	ppm	67 - 800	2440	NA	31300
Strontium	ppm	0.14 - 0.52	2.13	NA	848
Tantalum	ppm	ND	NA	NA	NA
Tellurium	ppm	ND	NA	NA	NA
Thallium	ppm	ND	ND	NA	ND

TABLE 2.9

SOLAR EVAPORATION POND 207B (CENTER)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (Center) Liquid		207B (Center) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Thorium	ppm	ND	NA	NA	ND
Tin	ppm	ND	0.109	NA	ND
Titanium	ppm	ND	NA	NA	NA
Tungsten	ppm	ND	NA	NA	NA
Vanadium	ppm	ND - 0.0081	NA	NA	NA
Zirconium	ppm	ND - 0.004	NA	NA	NA
Zinc	ppm	ND - 0.041	ND	NA	186
VOLATILE ORGANICS					
Acetone	ppb	NA	ND	NA	ND
Methylene Chloride	ppb	NA	ND	NA	ND
Tetrachloroethene	ppb	NA	ND	NA	ND
SEMIVOLATILE					
Acenaphthene	ppb	NA	ND	NA	ND
Bis(2-ethyl hexyl) phthalate	ppb	NA	ND	NA	ND
4-Chloro-3-methylphenol	ppb	NA	ND	NA	ND
2-Chlorophenol	ppb	NA	ND	NA	ND
1,4-Dichlorobenzene	ppb	NA	ND	NA	ND
2,4-Dinitrotoluene	ppb	NA	ND	NA	ND
Di-n-butyl phthalate	ppb	NA	ND	NA	ND
Fluoranthene	ppb	NA	ND	NA	ND
N-Nitroso-di-propylamine	ppb	NA	ND	NA	ND
Phenol	ppb	NA	ND	NA	ND
Phenols, Total	ppb	NA	NA	NA	NA
Pyrene	ppb	NA	ND	NA	ND
1,2,4-Trichlorobenzene	ppb	NA	ND	NA	ND
PESTICIDES/PCBs					

TABLE 2.9

SOLAR EVAPORATION POND 207B (CENTER)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (Center) Liquid		207B (Center) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Atrazine	ppb	NA	9	NA	ND
Diazinon	ppb	NA	ND	NA	ND
Simazine	ppb	NA	ND	NA	ND

References: Rockwell International, 1988a, Solar Evaporation Ponds Closure Plan  
Dames and Moore, 1991, A Summary of Chemical Analyses of Sludge and Water

NA -- Not Analyzed  
ND -- Not Detected



TABLE 2.10  
SOLAR EVAPORATION POND 207B (SOUTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS

Compound	Units	207B (South) Liquid		207B (South) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
ANIONS					
Ammonia	ppm	NA	0.97	NA	256
Bicarbonate	ppm	NA	ND	NA	ND
Carbonate	ppm	NA	190	NA	ND
Chloride	ppm	NA	745	NA	11300
Cyanide, Total	ppm	NA	0.509	NA	ND
Fluoride	ppm	NA	72.5	NA	ND
Nitrate, N	ppm	NA	1800	NA	11000
Nitrite	ppm	NA	100	NA	860
Phosphate, Ortho	ppm	NA	ND	NA	23
Phosphate, Total	ppm	NA	2.6	NA	260
Sulfate	ppm	NA	784	NA	8530
Sulfide	ppm	NA	1.0	NA	ND
TKN-N	ppm	NA	ND	NA	12100
RADIONUCLIDES					
Americium -241	pCi/l	NA	0.1	NA	NA
Americium -241	pCi/g	NA	NA	NA	2.4
Plutonium -239	pCi/l	NA	0.1	NA	NA
Plutonium -239	pCi/g	NA	NA	NA	1.9
Uranium -234	pCi/l	NA	760	NA	NA
Uranium -234	pCi/g	NA	NA	NA	130
Uranium -235	pCi/l	NA	31	NA	NA
Uranium -235	pCi/g	NA	NA	NA	2.9
Uranium -238	pCi/l	NA	870	NA	NA
Uranium -238	pCi/g	NA	NA	NA	150

TABLE 2.10

SOLAR EVAPORATION POND 207B (SOUTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (South) Liquid		207B (South) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Uranium	pCi/l	NA	ND	NA	ND
Tritium	pCi/l	NA	NA	NA	NA
Tritium	pCi/g	NA	NA	NA	NA
Gross Alpha	pCi/l	NA	1600	NA	
Gross Alpha	pCi/g	NA	NA	NA	150
Gross Beta	pCi/l	NA	2300	NA	
Gross Beta	pCi/g	NA	NA	NA	530
MISCELLANEOUS TESTS					
Alkalinity, Total	ppm	NA	860	NA	3000
Conductivity @ 25C	uMHO s	NA	23000	NA	NA
Total Dissolved Solids	ppm	NA	16000	NA	NA
Total Organic Carbon	ppm	NA	297	NA	21000
Total Suspended Solids	%	NA	6.0	NA	NA
pH	units	NA	9.2	NA	NA
METALS					
Aluminum	ppm	NA	ND	NA	1870
Antimony	ppm	NA	ND	NA	ND
Arsenic	ppm	NA	0.0164	NA	ND
Barium	ppm	NA	ND	NA	ND
Beryllium	ppm	NA	NA	NA	NA
Bismuth	ppm	NA	ND	NA	ND
Boron	ppm	NA	2.77	NA	138
Cadmium	ppm	NA	ND	NA	28
Calcium	ppm	NA	18.9	NA	124000
Cerium	ppm	NA	NA	NA	NA

TABLE 2.10

SOLAR EVAPORATION POND 207B (SOUTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (South) Liquid		207B (South) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Cesium	ppm	NA	NA	NA	NA
Cobalt	ppm	NA	NA	NA	NA
Chromium, Total	ppm	NA	0.0228	NA	30
Chromium, Hexavalent	ppm	NA	NA	NA	NA
Copper	ppm	NA	0.037	NA	95
Germanium	ppm	NA	NA	NA	NA
Iron	ppm	NA	ND	NA	2530
Lead	ppm	NA	ND	NA	9
Lithium	ppm	NA	2.670	NA	ND
Magnesium	ppm	NA	180	NA	9680
Manganese	ppm	NA	0.0182	NA	107
Mercury	ppm	NA	0.001	NA	ND
Molybdenum	ppm	NA	0.122	NA	ND
Nickel	ppm	NA	0.040	NA	ND
Niobium	ppm	NA	NA	NA	NA
Phosphorous	ppm	NA	NA	NA	NA
Potassium	ppm	NA	791	NA	7370
Rubidium	ppm	NA	NA	NA	NA
Selenium	ppm	NA	ND	NA	ND
Silicon	ppm	NA	0.952	NA	4320
Silver	ppm	NA	ND	NA	ND
Sodium	ppm	NA	2940	NA	24200
Strontium	ppm	NA	2.37	NA	720
Tantalum	ppm	NA	NA	NA	NA
Tellurium	ppm	NA	NA	NA	NA
Thallium	ppm	NA	ND	NA	ND

TABLE 2.10

SOLAR EVAPORATION POND 207B (SOUTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (South) Liquid		207B (South) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Thorium	ppm	NA	NA	NA	NA
Tin	ppm	NA	ND	NA	ND
Titanium	ppm	NA	NA	NA	NA
Tungsten	ppm	NA	NA	NA	NA
Vanadium	ppm	NA	NA	NA	NA
Zirconium	ppm	NA	NA	NA	NA
Zinc	ppm	NA	0.037	NA	126
VOLATILE ORGANICS					
Acetone	ppb	NA	ND	NA	ND
Methylene Chloride	ppb	NA	ND	NA	ND
Tetrachloroethene	ppb	NA	ND	NA	130
SEMIVOLATILE					
Acenaphthene	ppb	NA	ND	NA	ND
Bis(2-ethyl hexyl)phthalate	ppb	NA	ND	NA	ND
4-Chloro-3-methylphenol	ppb	NA	ND	NA	ND
2-Chlorophenol	ppb	NA	ND	NA	ND
1,4-Dichlorobenzene	ppb	NA	ND	NA	ND
2,4-Dinitrotoluene	ppb	NA	ND	NA	ND
Di-n-butyl phthalate	ppb	NA	ND	NA	ND
Fluoranthene	ppb	NA	ND	NA	ND
N-Nitroso-di-propylamine	ppb	NA	ND	NA	ND
Phenol	ppb	NA	ND	NA	ND
Phenols, Total	ppb	NA	NA	NA	NA
Pyrene	ppb	NA	ND	NA	ND
1,2,4-Trichlorobenzene	ppb	NA	ND	NA	ND

TABLE 2.10

SOLAR EVAPORATION POND 207B (SOUTH)  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207B (South) Liquid		207B (South) Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
PESTICIDES/PCBs					
Atrazine	ppb	NA	13	NA	ND
Diazinon	ppb	NA	ND	NA	ND
Simazine	ppb	NA	ND	NA	ND

References: Rockwell International, 1988a, Solar Evaporation Ponds Closure Plan  
Dames and Moore, 1991, A Summary of Chemical Analyses of Sludge and Water

NA -- Not Analyzed

ND -- Not Detected

TABLE 2.11  
SOLAR EVAPORATION POND 207C  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS

Compound	Units	207C Liquid		207C Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
ANIONS					
Ammonia	ppm	NA	ND	NA	ND
Bicarbonate	ppm	NA	4000	NA	ND
Carbonate	ppm	NA	25000	NA	ND
Chloride	ppm	NA	18300	NA	5360
Cyanide, Total	ppm	ND-1.9	9650	NA	3200
Fluoride	ppm	NA	ND	NA	22800
Nitrate, N	ppm	0.4-21400	2600	NA	97000
Nitrite	ppm	NA	2500	NA	800
Phosphate, Ortho	ppm	NA	390	NA	ND
Phosphate, Total	ppm	NA	431	NA	1700
Sulfate	ppm	NA	12200	NA	110000
Sulfide	ppm	NA	10	NA	ND
TKN-N	ppm	NA	ND	NA	ND
RADIONUCLIDES					
Americium -241	pCi/l	ND-13000	8.6	NA	NA
Americium -241	pCi/g	NA	NA	NA	1.7
Plutonium -239	pCi/l	210-2100	670	NA	NA
Plutonium -239	pCi/g	NA	NA	NA	15
Uranium -234	pCi/l	NA	2600	NA	NA
Uranium -234	pCi/g	NA	NA	NA	5.2
Uranium -235	pCi/l	NA	120	NA	NA
Uranium -235	pCi/g	NA	NA	NA	0.8
Uranium -238	pCi/l	NA	3900	NA	NA
Uranium -238	pCi/g	NA	NA	NA	31

TABLE 2.11

SOLAR EVAPORATION POND 207C  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207C Liquid		207C Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Uranium	pCi/l	1400-40000	ND	NA	ND
Tritium	pCi/l	ND-6400	ND	NA	NA
Tritium	pCi/g	NA	NA	NA	NA
Gross Alpha	pCi/l	10000-46000	72000	NA	
Gross Alpha	pCi/g	NA	NA	NA	18
Gross Beta	pCi/l	405-44000	170000	NA	
Gross Beta	pCi/g	NA	NA	NA	420
MISCELLANEOUS TESTS					
Alkalinity, Total	ppm	NA	45000	NA	24000
Conductivity @ 25C	uMHO s	NA	610000	NA	NA
Total Dissolved Solids	ppm	93900-175800	400000	NA	NA
Total Organic Carbon	ppm	NA	54.9	NA	NA
Total Suspended Solids	%	NA	76	NA	NA
pH	ppm	7.7-12.5	10.2	NA	NA
METALS					
Aluminum	ppm	NA	ND	NA	97
Antimony	ppm	NA	ND	NA	ND
Arsenic	ppm	NA	ND	NA	ND
Barium	ppm	NA	ND	NA	ND
Beryllium	ppm	ND-0.6	ND	NA	ND
Bismuth	ppm	NA	ND	NA	ND
Boron	ppm	NA	360	NA	117
Cadmium	ppm	NA	0.312	NA	6
Calcium	ppm	NA	ND	NA	ND
Cerium	ppm	NA	NA	NA	NA

TABLE 2.11

**SOLAR EVAPORATION POND 207C**  
**SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS**  
(continued)

Compound	Units	207C Liquid		207C Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Cesium	ppm	NA	NA	NA	NA
Cobalt	ppm	NA	NA	NA	NA
Chromium, Total	ppm	NA	2.36	NA	18
Chromium, Hexavalent	ppm	NA	NA	NA	NA
Copper	ppm	NA	6.79	NA	6
Germanium	ppm	NA	NA	NA	NA
Iron	ppm	NA	ND	NA	36
Lead	ppm	NA	ND	NA	ND
Lithium	ppm	NA	ND	NA	43
Magnesium	ppm	NA	NA	NA	ND
Manganese	ppm	NA	ND	NA	ND
Mercury	ppm	NA	ND	NA	ND
Molybdenum	ppm	NA	ND	NA	ND
Nickel	ppm	NA	5.09	NA	ND
Niobium	ppm	NA	NA	NA	NA
Phosphorous	ppm	NA	NA	NA	NA
Potassium	ppm	NA	78700	NA	273000
Rubidium	ppm	NA	NA	NA	NA
Selenium	ppm	NA	ND	NA	ND
Silicon	ppm	NA	30.1	NA	422
Silver	ppm	NA	ND	NA	ND
Sodium	ppm	NA	102000	NA	50900
Strontium	ppm	NA	ND	NA	ND
Tantalum	ppm	NA	NA	NA	NA
Tellurium	ppm	NA	NA	NA	NA
Thallium	ppm	NA	ND	NA	ND



TABLE 2.11

SOLAR EVAPORATION POND 207C  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207C Liquid		207C Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
Thorium	ppm	NA	NA	NA	NA
Tin	ppm	NA	ND	NA	ND
Titanium	ppm	NA	NA	NA	NA
Tungsten	ppm	NA	NA	NA	NA
Vanadium	ppm	NA	NA	NA	NA
Zirconium	ppm	NA	NA	NA	NA
Zinc	ppm	NA	ND	NA	6
VOLATILE ORGANICS					
Acetone	ppb	NA	43	NA	ND
Methylene Chloride	ppb	NA	ND	NA	ND
Tetrachloroethene	ppb	NA	ND	NA	ND
SEMIVOLATILE					
Acenaphthene	ppb	NA	ND	NA	ND
Bis(2-ethyl hexyl)phthalate	ppb	NA	ND	NA	ND
4-Chloro-3-methylphenol	ppb	NA	ND	NA	ND
2-Chlorophenol	ppb	NA	ND	NA	ND
1,4-Dichlorobenzene	ppb	NA	ND	NA	ND
2,4-Dinitrotoluene	ppb	NA	ND	NA	ND
Di-n-butyl phthalate	ppb	NA	ND	NA	ND
Fluoranthene	ppb	NA	ND	NA	ND
N-Nitroso-di-propylamine	ppb	NA	ND	NA	ND
Phenol	ppb	NA	ND	NA	ND
Phenols, Total	ppb	13-35	NA	NA	NA
Pyrene	ppb	NA	ND	NA	ND
1,2,4-Trichlorobenzene	ppb	NA	ND	NA	ND

TABLE 2.11

SOLAR EVAPORATION POND 207C  
SUMMARY OF LIQUID AND SLUDGE SAMPLING RESULTS  
(continued)

Compound	Units	207C Liquid		207C Sludge	
		1984-1988 Range	1991 Composite	1984-1988 Range	1991 Composite
PESTICIDES/PCBs					
Atrazine	ppb	NA	ND	NA	ND
Diazinon	ppb	NA	2.8	NA	ND
Simazine	ppb	NA	7.5	NA	ND

References: Rockwell International, 1988a, Solar Evaporation Ponds Closure Plan  
Dames and Moore, 1991, A Summary of Chemical Analyses of Sludge and Water

NA -- Not Analyzed  
ND -- Not Detected

TABLE 2.12

1989 SOIL SAMPLE PARAMETERS LIST

Metals

Aluminum  
Antimony  
Arsenic  
Barium  
Beryllium  
Cadmium  
Calcium  
Cesium  
Chromium  
Cobalt  
Copper  
Iron  
Lead  
Lithium  
Magnesium  
Manganese  
Mercury  
Molybdenum  
Nickel  
Potassium  
Selenium  
Silver  
Sodium  
Strontium  
Thallium  
Tin  
Vanadium  
Zinc

Anions

Nitrate  
Nitrate/Nitrite  
Sulfide

Radiochemistry

Borings P207889, P207989, P208889, P208989,  
P209589, P209689, P209789  
  
Americium -241  
Cesium -137  
Gross Alpha  
Gross Beta  
Plutonium -239  
Radium -226  
Radium -228  
Strontium -90  
Tritium  
Total Uranium  
Uranium -233, -234  
Uranium -235  
Uranium -238

Reference: EG&G Rocky Flats, Inc. RFEDs Database

TABLE 2.13  
SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR SELECTED METALS AND INORGANICS  
RANGE OF DETECTION (µg/g)

Borehole Number	Depth (feet)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
P207389	3.0-19.3	3760-8840	ND	ND-3.9	48.2-74.5	1.9-2.4	ND	5.4-8.3	7.4-15.2
P207489	0.0-10.0	6490-30400	ND	ND-8.8	40.4-120	1.4-8.7	ND	3.2-81.2	5.3-26.6
P207589	3.0-21.4	7650-11800	ND	ND-17.1	ND-155	2.8-3.2	ND	10.1-11.4	5.8-23.7
P207689	0.0-15.3	7340-8920	ND	ND-4.5	ND-147	2.1-2.7	ND	6.4-7.1	7.0-10.4
P207789	0.0-24.3	6370-10400	ND	ND-5.6	ND-202	1.9-3.0	ND	6.3-8.9	6.3-13.1
P207889	0.0-5.5	7480-32700	ND	2.8-9.9	108-269	2.3-9.1	ND	6.5-28.7	6.1-14.4
P207989	0.0-18.2	7240-11700	ND	ND-7.3	70.1-216	1.9-3.5	ND	7.4-7.7	6.4-35.9
P208889	3.5-15.3	5290-7200	ND	2.6-7.7	59.5-11600	1.5-2.5	ND	5.3-6.1	8.1-15.1
P208989	0.0-14.6	5200-8020	ND	2.6-15.5	76.1-1100	1.5-2.1	ND	5.2-8.8	7.7-12.0
P209089	3.5-17.5	4780-17300	ND	ND-6.8	ND-196	1.4-4.2	ND-60.4	4.6-15	7.3-19.1
P209189	3.0-22.3	4140-15400	ND	2.6-13.6	ND-97.2	2.1-4.5	ND	5.9-14.5	ND-12.0
P209289	0.0-17.8	3240-13200	ND	2.8-6.8	56.3-91	2.6-7.2	ND	7.4-16.3	ND-24.6
P209389	3.0-26.2	2190-12400	ND	ND-5.6	58.2-93	2.5-7.9	ND	4.4-16.1	10.3-14.9
P209489	3.0-21.0	2830-5010	ND	4.3-24.6	ND-76.4	ND-1.7	ND	3.8-6.2	ND-13.8
P209589	0.0-14.5	5360-12900	ND	ND-6.4	ND-97.6	1.4-3.5	ND	4.9-10.4	ND-12.2
P209689	6.2-24.2	9130-8770	ND	ND-12.5	ND-174	2.3-4.1	ND	8.3-10.2	5.9-73.6
P209789	0.0-15.2	5940-7800	ND	ND-2.2	ND-69.4	1.5-2.2	ND	5.6-7.3	ND-8.8
P209889	0.0-15.9	5350-10500	ND	2.5-3.6	45.9-181	1.9-2.9	ND	5.8-9.9	8.7-17.5
P210189	3.0-26.6	6390-23000	ND	ND-3.8	ND-203	ND-1.7	ND	7.6-27.1	ND-24.3
P210289	3.0-19.0	6130-18200	ND	3.1-14.1	ND-254	2.4-5.5	ND	7.2-18.1	7.3-18.0

**TABLE 2.13**

**SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR SELECTED METALS AND INORGANICS**

**RANGE OF DETECTION ( $\mu\text{g/g}$ )**

**(continued)**

Borehole Number	Depth (feet)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper
Upper Tolerance Level* in Background Alluvial Samples		13418	ND	4.3	79.5	4.7	ND	20.0	11.1
Upper Tolerance Level* in Background Bedrock Samples		10428	ND	4.0	121.9	3.4	ND	10.3	16.3

• = Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.

TABLE 2.13  
SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR SELECTED METALS AND INORGANICS  
RANGE OF DETECTION (µg/g)  
(continued)

Borehole Number	Depth (feet)	Lead	Lithium	Mercury	Nickel	Selenium	Silver	Thallium	Zinc	Nitrate/Nitrate (mg/kg)
P207389	3.0-19.3	ND	19.4-23.5	ND	ND-12.5	ND	ND	ND	27.6-46.5	1.1-5.3
P207489	0.0-10.0	ND	18.4-21.7	ND	ND-37.5	ND	ND-5.8	ND	23.3-62.1	1.2-8.3
P207589	3.0-21.4	5.4-24.6	3.7-18.8	0.48-1.1	ND-42.5	ND	ND-2.9	ND	13.7-124	1.6-21
P207689	0.0-15.3	6.9-13.9	5.1-11.8	ND-0.12	ND	ND	ND	ND	ND-10.1	6.3-8.3
P207789	0.0-24.3	10.5-24.7	3.1-13.6	ND-0.18	ND	ND	ND	ND	ND-29.4	3.6-14
P207889	0.0-5.5	4.7-16.7	9.6-23.9	0.12-0.37	ND-41.7	ND	ND-3.1	ND	10.1-45.3	6.4-8.1
P207989	0.0-18.2	6-8.9	6.7-10.1	0.21-0.25	ND-23.0	ND	ND	ND	ND-93.4	2.5-7.6
P208889	3.5-15.3	9.3-20.3	5.6-5.7	ND	ND	ND	ND	ND	29.2-37.9	1900-3400
P208989	0.0-14.6	2.4-27.5	2.3-3.1	ND	ND-21.1	ND	ND	ND	11.2-56.2	1.4-51
P209089	3.5-17.5	8.6-21.7	2.3-35.8	ND-0.24	9.2-35.7	ND	ND	ND	15.8-101	1.6-182
P209189	3.0-22.3	6.4-14.7	2.3-9.2	ND-0.19	9.2-15.8	ND	ND	ND	12.8-35.9	1.6-180
P209289	0.0-17.8	ND-4.9	18.2-23	ND	11.7-33.5	ND	ND-5.3	ND	21.2-90.9	ND-21
P209389	3.0-26.2	ND-3.1	15.8-22.2	ND	ND-28.9	ND	ND-5.6	ND	28.0-59.8	ND-4.0
P209489	3.0-21.0	9.5-14.5	2.2-3.6	ND	ND-11.3	ND	ND	ND	8.4-35.8	4.0-32
P209589	0.0-14.5	10.3-17.6	4.1-9.1	ND	ND	ND	ND	ND	23.5-40.6	560-1300
P209689	6.2-24.2	6.9-30.9	4.3-10.6	ND-0.44	ND-133	ND	ND-3.7	ND	ND-487	2.2-43
P209789	0.0-15.2	3.9-86.9	5.3-8.9	ND-0.32	ND	ND	5.6-7.3	ND	ND	3.2-12
P209889	0.0-15.9	11.1-30.3	4.4-11.8	ND	ND	ND-2.3	ND	ND	29.0-54.8	630-1400
P210189	3.0-26.6	2.6-14	18.6-22.8	ND	ND-21.9	ND-1.3	ND	ND	12.8-82.6	3.4-420
P210289	3.0-19.0	20.2-31.1	4.1-11.9	ND-0.17	ND-10.5	ND	ND	ND	15.5-66.6	1.2-21
Upper Tolerance Level* in Background Alluvial Samples		12.2	ND	NA	21.4	ND	ND	ND	39.7	NC (Mean = 0.8583)

TABLE 2.13

SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR SELECTED METALS AND INORGANICS  
RANGE OF DETECTION ( $\mu\text{g/g}$ )  
(continued)

Upper Tolerance Level* in Background Bedrock Samples	18.6	11.6	NA	20.2	ND	ND	ND	62.3	NC (Mean = 0.8953)
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\* = Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.  
ND = Not Detected above detection limit  
NA = Not Analyzed  
NC = Upper tolerance level Not Calculated

TABLE 2.14  
SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR RADIONUCLIDES  
RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)

Borehole Number	Depth (feet)	Cesium-137	Gross Alpha	Gross Beta	Plutonium-239	Radium-226	Strontium-90
P207889	0.0-5.5	0(0.01)	0(7)-10(8)	11(5)-13(5)	0(0.01)-0.02(0.02)	0.5(0.1)-0.7(0.1)	-0.6(0.7)- -0.1(0.4)
P207989	0.0-18.2	0(0.01)	12(9)-29(10)	14(5)-28(6)	0(0.01)	0.7(0.1)-1.3(0.1)	-0.4(0.5)- -0.1(0.5)
P208889	3.5-15.3	0(0.01)	17(9)-28(10)	16(5)-29(6)	0(0.01)	0.7(0.1)-1.1(0.1)	-0.4(0.5)-0(0.6)
P208989	0.0-14.6	0(0.01)	24(14)-37(16)	21(6)-30(6)	0(0.01)-0.01(0.01)	0.7(0.1)-1.1(0.1)	-0.2(0.4)-0.1(0.6)
P209589	0.0-14.5	0(0.01)	17(8)-33(11)	22(5)-29(6)	0(0.01)-0.17(0.03)	0.9(0.1)-1.1(0.1)	-0.3(0.7)- -0.2(0.6)
P209689	6.2-24.2	0(0.01)	14(9)-29(10)	23(6)-32(6)	0(0.01)-0.01(0.02)	0.6(0.1)-1.0(0.1)	-0.4(0.6)-0.1(0.6)
P209789	0.0-15.2	0(0.01)	17(9)-25(10)	23(5)-28(6)	0(0.01)-0.03(0.02)	0.6(0.1)-0.9(0.1)	-0.5(0.5)- -0.1(0.4)
Upper Tolerance Level* in Background Alluvial Samples (pCi/g except Tritium pCi/ml)		0.07	38.36	36.82	0.015	0.65	0.73
Upper Tolerance Level* in Background Bedrock Samples (pCi/g except Tritium pCi/ml)		0.07	48.42	34.15	0.021	1.14	0.67

\* - Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.  
pCi/g = PicoCuries per gram  
pCi/ml = PicoCuries per milliliter  
NA = Not Analyzed



TABLE 2.14  
SUMMARY OF 1989 SOIL SAMPLING RESULTS FOR RADIONUCLIDES  
RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)

Borehole Number	Depth (feet)	Tritium (pCi/ml)	Total Uranium	Uranium -233/-234	Uranium -235	Uranium -238
P207889	0.0-5.5	-0.1(0.15)-0.07(0.15)	0.9-1.3	0.4(0.2)-0.8(0.2)	0(0.1)	0.5(0.1)-0.7(0.2)
P207989	0.0-18.2	-0.08(0.15)-0.79(0.17)	1.2-3.7	0.6(0.2)-1.9(0.4)	0(0.1)-0.1(0.1)	0.6(0.2)-1.7(0.4)
P208889	3.5-15.3	16(1)-36(1)	1.8-2.3	0.7(0.2)-1.2(0.2)	0(0.1)	1.0(0.2)-1.1(0.2)
P208989	0.0-14.6	0.63(0.15)-0.87(0.16)	1.5-2.0	0.4(0.2)-0.8(0.2)	0(0.1)-0.2(0.1)	0.7(0.2)-1.3(0.3)
P209589	0.0-14.5	5.2(0.2)-12(1)	1.4-2.8	0.7(0.2)-1.4(0.3)	0(0.1)-0.1(0.1)	0.7(0.2)-1.3(0.3)
P209689	6.2-24.2	-0.01(0.14)-2.8(0.2)	0.9-1.5	0.5(0.2)-0.7(0.2)	0(0.1)	0.4(0.1)-0.8(0.2)
P209789	0.0-15.2	-0.15(0.15)-1.5(0.2)	0.8-1.6	0.2(0.2)-0.7(0.2)	0(0.1)-0.1(0.1)	0.5(0.2)-0.9(0.2)
Upper Tolerance Level* in Background Alluvial Samples (pCi/g except Tritium pCi/ml)		0.41	NA	0.66	0.07	0.68
Upper Tolerance Level* in Background Bedrock Samples (pCi/g except Tritium pCi/ml)		0.29	NA	0.98	0.18	1.04

\* = Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.  
pCi/g = PicoCuries per gram  
pCi/ml = PicoCuries per milliliter  
NA = Not Analyzed

TABLE 2.15  
SUMMARY OF HISTORICAL SOIL SAMPLING RESULTS FOR RADIONUCLIDES  
RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)

Borehole Number	Depth (feet)	Gross Alpha	Gross Beta	Plutonium -239	Strontium -90
SP0187	23	10(12)-110(20)	8.6(6.1)-33(7)	-0.03(0.13)-18(1)	-0.3(0.6)-0.2(0.4)
SP0287	13	11(14)-21(9)	7.1(5.6)-36(7)	-0.02(0.13)-0.13(0.15)	0.1(0.4)-0.4(0.3)
SP0387	16	21(14)-22(14)	15(6)-21(7)	-0.01(0.14)-0.05(0.15)	-0.1(0.4)-0.1(0.3)
SP0487	32	11(9)-57(13)	12(6)-31(6)	-0.06(0.07)-0.14(0.11)	-0.2(0.5)-0.6(0.6)
SP0587	26	16(12)-48(12)	13(6)-22(6)	-0.02(0.08)-0.13(0.11)	-0.2(0.7)-0.1(0.7)
SP0687	26	14(8)-39(11)	13(5)-30(6)	-0.02(0.07)-0.52(0.16)	-0.2(1.0)-0.6(0.7)
SP0787	26	11(8)-33(11)	11(5)-26(6)	-0.02(0.09)-2.2(0.3)	-0.2(0.7)-0.6(0.9)
SP0887	9	12(12)-32(11)	14(6)-28(6)	-0.01(0.13)-0.03(0.11)	-0.4(0.7)-0.4(0.7)
SP0987	8	18(10)-25(11)	19(6)-28(6)	-0.05(0.07)-0.02(0.09)	-0.2(0.6)-0.1(0.6)
SP1087	24	16(12)-42(16)	17(6)-29(7)	-0.06(0.10)-3.5(0.3)	-0.6(0.7)-1.1(0.9)
SP1187	29	20(10)-38(11)	19(6)-32(6)	-0.06(0.08)-0.05(0.11)	-0.3(0.8)-0.1(0.6)
SP1287	41	9(12)-39(12)	6.6(5.5)-31(7)	-0.05(0.07)-0.03(0.10)	-0.5(0.6)-0.8(0.8)
SP1387	11	16(12)-36(15)	18(6)-29(7)	-0.06(0.09)-0.05(0.12)	-0.4(0.5)-0.5(0.9)
SP1487	4	26(11)-31(12)	20(6)-23(6)	-0.04(0.08)-0.02(0.09)	-0.1(0.6)-0.1(0.7)
SP1587	17	10(9)-31(10)	10(6)-31(6)	-0.04(0.07)-0.04(0.10)	-0.1(0.6)-0.3(0.7)
SP1687	11	23(13)-59(18)	19(6)-31(7)	-0.05(0.14)-9.0(0.6)	-0.4(0.6)-0.0(0.6)
1886	UD	15(9)-27(10)	22(6)-33(6)	-0.01(0.01)-0.01(0.02)	NA
2086	UD	28(11)-43(13)	17(6)-36(7)	-0.01(0.02)-0.37(0.06)	NA
2286	UD	23(13)-29(14)	25(6)-40(7)	0.0(0.02)-0.06(0.03)	NA
2586	UD	26(11)-46(16)	19(6)-25(6)	0.01(0.02)-0.42(0.05)	NA
2786	UD	23(11)-68(15)	20(6)-46(7)	-0.01(0.02)	NA
Upper Tolerance Level* in Background Alluvial Samples (pCi/g except Tritium pCi/ml)		38.36	36.82	0.015	0.73

TABLE 2.15  
SUMMARY OF HISTORICAL SOIL SAMPLING RESULTS FOR RADIONUCLIDES  
RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)  
(continued)

Upper Tolerance Level* in Background Bedrock Samples (pCi/g except Tritium pCi/ml)	48.42	34.15	0.021	0.67
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\* = Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.

NA = Not Analyzed

ND = Not Detected above detection limit

UD = Unknown sample Depth

TABLE 2.15  
SUMMARY OF HISTORICAL SOIL SAMPLING RESULTS FOR RADIONUCLIDES  
RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)  
(continued)

Borehole Number	Depth (feet)	Tritium (pCi/ml)	Uranium -233/-234	Uranium -238	Americium -241
SP0187	23	ND	0.40(0.12)-4(0.6)	0.53(0.13)-2.8(0.5)	0.02(0.06)-2.2(0.2)
SP0287	13	ND	0.26(0.11)-1.5(0.3)	0.19(0.10)-1.2(0.2)	0.01(0.06)-0.22(0.13)
SP0387	16	ND-2(0.3)	0.61(0.18)-0.77(0.18)	0.47(0.17)-0.70(0.18)	0.03(0.07)-0.09(0.12)
SP0487	32	ND-1.3(0.3)	0.52(0.12)-1.6(0.4)	0.66(0.14)-1.3(0.3)	0(0.06)-1.2(0.2)
SP0587	26	ND-3.3(0.3)	0.50(0.13)-1.7(0.2)	0.39(0.11)-1.4(0.2)	0(0.04)-0.13(0.08)
SP0687	26	ND	0.50(0.13)-1.8(0.3)	0.38(0.11)-1.7(0.2)	0.01(0.09)-0.5(0.17)
SP0787	26	ND-2.3(0.3)	0.42(0.11)-1.2(0.2)	0.41(0.11)-1.6(0.2)	-0.06(0.09)-0.61(0.18)
SP0887	9	2.8(0.3)-3.8(0.4)	0.87(0.15)-1.1(0.2)	0.65(0.13)-1.0(0.2)	0.01(0.07)-0.06(0.09)
SP0987	8	ND-0.86(0.28)	0.45(0.12)-0.94(0.18)	0.43(0.11)-1.1(0.2)	0.0(0.06)-0.06(0.08)
SP1087	24	ND-0.65(0.28)	0.45(0.16)-3.7(0.4)	0.58(0.14)-1.4(0.2)	-0.03(0.04)-0.59(0.19)
SP1187	29	ND	0.77(0.21)-1.7(0.2)	0.83(0.21)-1.7(0.2)	-0.04(0.05)-0.02(0.06)
SP1287	41	ND	0.38(0.12)-1.7(0.3)	0.57(0.15)-1.6(0.2)	-0.03(0.04)-0.05(0.06)
SP1387	11	ND	0.66(0.18)-1.7(0.2)	0.93(0.19)-1.5(0.2)	-0.03(0.06)-0.03(0.07)
SP1487	4	ND	0.67(0.14)-0.93(0.17)	0.64(0.14)-1.1(0.2)	-0.06(0.08)-0.03(0.05)
SP1587	17	ND	0.64(0.14)-1.2(0.2)	0.51(0.13)-1.2(0.2)	-0.04(0.09)-0.05(0.10)
SP1687	11	ND	0.49(0.12)-1.1(0.2)	0.55(0.13)-0.78(0.16)	0.0(0.09)-0.96(0.26)
1886	UD	-0.02(0.21)-0.19(0.21)	0.83(0.20)-1.1(0.2)	1.0(0.2)-1.2(0.2)	0(0.01)-0.01(0.02)
2086	UD	0.06(0.21)-3.9(0.3)	0.44(0.15)-1.3(0.2)	1.4(0.3)-2.7(0.3)	0(0.01)-0.30(0.06)
2286	UD	1.7(0.2)-2.0(0.3)	0.71(0.26)-2.0(0.5)	1.2(0.3)-1.8(0.4)	0(0.02)-0.01(0.02)
2586	UD	0.06(0.22)-3.3(0.3)	0.69(0.14)-0.92(0.22)	0.82(0.15)-1.3(0.3)	0(0.01)-0.09(0.04)
2786	UD	1.5(0.2)-11(1)	0.8(0.2)-1.5(0.3)	1.1(0.2)-1.3(0.2)	-0.05(0.06)-0.01(0.02)
Upper Tolerance Level* in Background Alluvial Samples (pCi/g except Tritium pCi/ml)		0.41	0.66	0.68	0.014

TABLE 2.15

SUMMARY OF HISTORICAL SOIL SAMPLING RESULTS FOR RADIONUCLIDES

RANGE OF DETECTION PLUS COUNTING ERROR (pCi/g)

(continued)

Upper Tolerance Level* in Background Bedrock Samples (pCi/g except Tritium pCi/ml)	0.29	0.98	1.04	NA
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• = Reference: EG&G December 21, 1990, Background Geochemical Characterization Report: Rocky Flats Plant for 1989, Appendix B.  
NA = Not Analyzed  
ND = Not Detected above detection limit  
UD = Unknown sample Depth

## **APPENDIX F**

### **ESTIMATION OF AIRBORNE RADIONUCLIDE CONCENTRATIONS**

## APPENDIX F ESTIMATING AIRBORNE CONCENTRATIONS OF RADIOISOTOPES FROM SOILS

### Maximum Expected Airborne Concentrations

Airborne radionuclide concentrations for specific areas within OU4 have been estimated from liquid, soil, and sludge data located in Appendix E. Formulas and calculations have been derived from chapter 6 of EPA document number EPA 520/1-9-90-016, Transuranium Elements - Volume 2: Technical Basis For Remedial Actions. Pertinent sections of this document are included in this appendix.

The following equation was obtained from this document:

Expected Airborne Concentration = (Concentration) (Mass Loading) (Enrichment Factor) (Area Correction)

In order to calculate a worst case Maximum Expected Airborne Concentration (MAC), and keep worker exposures As Low As Reasonably Achievable (ALARA), three modifications have been made to the above equation.

First, the above equation estimates an expected airborne concentration for non-invasive activities performed on a work site. The modified equation multiplies the Expected Airborne Concentration by 30 to determine airborne radionuclide concentrations for invasive procedures to be performed at the OU4 work site. This modification is described in chapter 6 of the above referenced document. The modified formula for MACs for non-invasive procedures does not incorporate the correction factor of 30.

The second modification was to omit the Enrichment Factor from the original equation. With the Enrichment Factor removed, an assumption is made that all particulates being inhaled are of a respirable size.

The last modification made to the original equation was to omit the Area Correction term. With the Area Correction removed, the new Estimated Airborne Concentration makes the assumption that particulates are being generated from an area with infinite size.

Other factors are assumed when utilizing the modified equation. First, it is assumed that the wind is blowing 100 percent of the time across sources of contamination. Second, the Estimated Airborne Concentration is for surface level conditions rather than worker breathing zone conditions.

Given the above assumptions and changes to the original formula, the modified formula is as follows.

$$\text{Maximum Expected Airborne Concentration} = (\text{Soil Concentration}) (\text{Mass Loading}) (30)$$

Chapter 6 of the referenced DOE document, evaluates ambient air monitoring data from sampling performed at RFP. This chapter then estimates that Mass Loading at RFP is approximately  $15 \times 10^{-6}$  grams per cubic meter ( $\text{g}/\text{m}^3$ ). The following is a sample calculation utilized for radionuclides present in sludge and/or soil with specific activities measured in picoCuries per gram ( $\text{pCi}/\text{g}$ ). This formula assumes invasive procedures are being performed.

Given:

From Table 5.5, the americium-241 specific activity for Pond 207-A sludge is  $4400 \text{ pCi}/\text{g}$ .

$$\text{Mass Loading at RFP} = 15 \times 10^{-6} \text{ g}/\text{m}^3$$

$$\text{Maximum Expected Airborne Concentration} = (4400 \text{ pCi}/\text{g}) (15 \times 10^{-6} \text{ g}/\text{m}^3) (30)$$

$$\text{Maximum Expected Airborne Concentration} = 1.98 \text{ pCi}/\text{m}^3$$

In order to derive the MAC for non-invasive procedures, the following modified formula would be utilized given the same parameters as above:



Maximum Expected Airborne Concentration =  $(4400 \text{ pCi/g}) (15 \times 10^{-6} \text{ g/m}^3)$

Maximum Expected Airborne Concentration =  $0.07 \text{ pCi/m}^3$

A MAC can also be derived for radionuclides present in liquid. To determine the MAC for contaminants in liquid media, the specific activities in picoCuries per liter (pCi/l) must first be extrapolated to activity in pCi/g. This can be done by multiplying the activity in pCi/l by the density of water (1 liter per 1000 grams). This result is then multiplied by the specific humidity. According to Byers in General Meteorology, the specific humidity is the number of grams of water vapor in a gram of air. Byers also states that the specific humidity seldom exceeds 0.02 grams of water vapor in a gram of air. Once the specific activity of radionuclides in liquid are then extrapolated to a value in pCi/g, the MAC can be calculated exactly as above.

Given:

From Table 5.5, the specific activity of total uranium in Pond 207-C is 40,000 pCi/l;

The Maximum Specific Humidity is 0.02 grams of water vapor in a gram of air; and

Mass Loading at RFP is  $15 \times 10^{-6} \text{ g/m}^3$

Total Uranium Specific Activity = [Specific Activity (pCi/l)] (1 liter/1000g-water) (0.02g-water/g-air)

Total Uranium Specific Activity =  $(40,000 \text{ pCi/l}) (1 \text{ liter/1000g-water}) (0.02\text{g-water/g-air})$

Total Uranium Specific Activity =  $0.80 \text{ pCi/g of air}$

Maximum Expected Airborne Concentration =  $(0.80 \text{ pCi/g-air}) (15 \times 10^{-6} \text{ g/m}^3\text{-air}) (30)$

Maximum Expected Airborne Concentration =  $0.0004 \text{ pCi/m}^3$   
(For Invasive Procedures)

Once the MACs are determined for specific media, they can be directly compared to the radionuclide specific Derived Air Concentration (DAC). If the MAC is greater than one tenth of the DAC, respiratory protection must be worn.

Although the MAC and DAC are good tools utilized to estimate inhalation radionuclide dose, the MAC cannot be directly measured in the field. Therefore, one must calculate a maximum dust concentration which employees can be exposed to but still stay below the DAC. Respirable dust concentrations can be determined in the field with direct reading instruments. In order to calculate this maximum dust concentration, the following equation is used for invasive procedures. For non-invasive procedures, the correction factor of 30 is removed:

Maximum Dust Concentration Employees Can Be Exposed to And Still Inhale Activities Below the DAC =  $\{[(0.1) (\text{DAC})/(\text{Compound Specific Activity (pCi/g) (30)})] [1000 \text{ mg/1g}]\}$

Given:

From Table 5.6, the specific activity of americium-241 in Pond 207-A is 4400 pCi/g;

This is an invasive procedure; and

The DAC is 2.0 pCi/m<sup>3</sup> for americium-241

Maximum Dust Concentration Employees Can Be Exposed to And Still Inhale Activities Below the DAC =  $\{[(0.1) (2.0 \text{ pCi/m}^3)/(\text{4400 pCi/g) (30)}] [1000 \text{ mg/g}]\}$

Maximum Dust Concentration Employees Can Be Exposed To And Still Inhale Activities Below the DAC = 0.0002 mg/m<sup>3</sup>

## 6. RADIOLOGICAL ASSESSMENT - ROCKY FLATS PLANT

[Reprinted With Minor Changes from Response to Comments -  
EPA 520/4-78-010]

### 6.1 INTRODUCTION

This chapter presents an analysis of the potential hazards to individuals in the general population as a result of transuranium element contamination in the environs of the USDOE Rocky Flats Plant. It is intended primarily to serve as an illustrative example of how to carry out a comprehensive environmental assessment, and does not represent an evaluation of potential health hazards. Analysis is limited to data for the period 1970-77, when public concern about possible health hazards was greatest. The various pathways by which exposures might occur under present and projected land usages are examined and interpreted in terms of ambient levels of contamination.

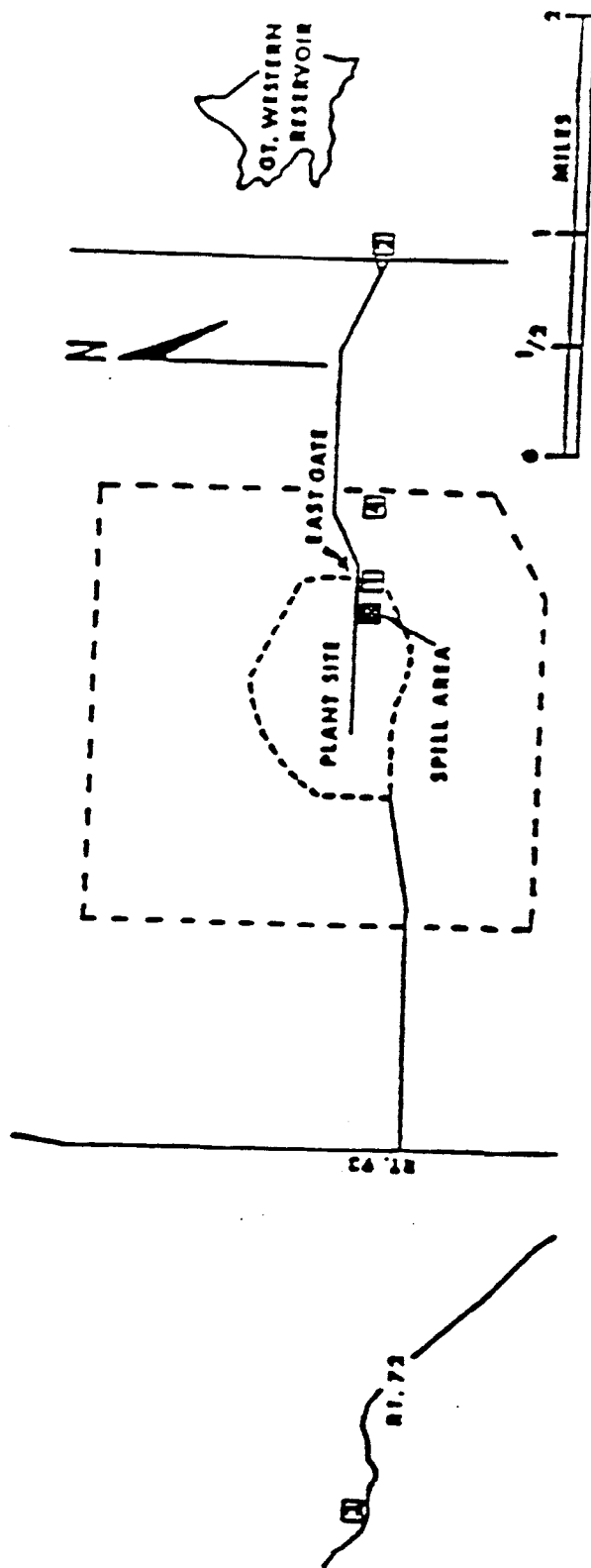
### 6.2 INHALATION PATHWAY

#### 6.2.1 AMBIENT AIR CONCENTRATIONS

Under normal operating conditions, minute quantities of plutonium and other radionuclides have been released to the atmosphere from the Rocky Flats Plant. These releases originated from the plant's ventilation and filtration system. Measurements of airborne radioactivity in the vicinity of Rocky Flats and the neighboring communities are made on a continuous basis. In addition to monitoring the effluent air from production and research facilities, the Rocky Flats facility maintains a system of high-volume ambient air samplers within the plant boundary, at off-site locations in the immediate vicinity of the plant, and in several communities nearby. Altogether the system comprises 21 air samplers operating continuously within and on the perimeter of the Rocky Flats security area, and another

25 samplers located at various distances and directions from the plant. The data from this network are reported on a monthly basis to the Rocky Flats Area Office of the Department of Energy (DOE), the Division of Occupational and Radiological Health of the Colorado Department of Health, the Denver Regional Office of the EPA, the Health Departments of Boulder and Jefferson Counties, and city officials in several communities near the plant.

In addition to the surveillance network maintained by the Rocky Flats Plant, the Health and Safety Laboratory (HASL) of DOE conducted a program of continuous air sampling for plutonium at the Plant since June 1970 in response to the discovery of elevated levels of plutonium found in soils at location which were then off-site. The HASL network consisted of four sampling locations (Figure 6-1), three of which were downwind (east) from the original location of the oil drum storage site and the fourth air sampler was located off-site and upwind from the Rocky Flats Plant. Air concentration data in attocuries of Pu-239 per cubic meter of air ( $\mu\text{Ci}/\text{m}^3$ ), as reported by this network on a monthly basis from June 1970 to March 1976, are given in Table 6-1. A significant downward trend with time in the level of plutonium in air at the stations downwind from the plant can be seen. It has been suggested by HASL that this downward trend is attributable to the weathering of the contaminated soil in the on-site vicinity of the original oil drum storage site. This weathering may be due to the movement of the plutonium from the surface down into the soil, as well as changes in the characteristics of the plutonium remaining on the surface. In addition to showing a decrease with time the data indicate a decrease in concentration with increasing distance downwind from the site of the original spill area. Based upon air and soil sampling, as well as the direction of the prevailing winds around Rocky Flats, HASL concluded in 1972 (2) that the original spill area was the primary source of plutonium in the Rocky Flats environment.



MAP OF ROCKY FLATS PLANT AND VICINITY  
INDICATING CONTINUOUS AIR SAMPLING SITES (1).

FIGURE 6-1

TABLE 6-1  
MONTHLY AVERAGE AIR CONCENTRATIONS OF PU-239  
AT ROCKY FLATS PLANT  
(Attocuries /Cubic Meter)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
<b>SITE #1</b>												
1970	--	--	--	--	--	--	1250.00	790.00	850.00	693.00	2260.00	962.00
1971	1960.00	--	7140.00 <sup>a</sup>	9730.00	4920.00	3800.00	2980.00	3330.00	4040.00	5770.00	5770.00	3160.00
1972	3430.00	1670.00	4610.00	1440.00	2080.00	6610.00	4720.00	1380.00	--	1620.00	498.00	1860.00
1973	1160.00	3640.00	3320.00	612.00	1780.00	3040.00	2920.00	3320.00	1050.00	2010.00	1810.00	1690.00
1974	402.00	802.00	891.00	1810.00	3060.00	5470.00	2670.00	3330.00	1120.00	407.00	580.00	643.00
1975	1260.00	1360.00	1780.00	2180.00	2190.00	1160.00	567.00	426.00	179.00	--	1220.00	655.00
1976	680.00	1240.00	864.00	--	--	--	--	--	--	--	--	--
<b>SITE #2</b>												
1972	--	--	--	--	--	--	98.90	55.50	119.00	609.00	48.50	45.20
1973	37.80	57.70	55.60	716.00 <sup>c</sup>	51.80	37.70	92.10	65.00	152.00	31.50	25.20	76.30
1974	16.80	23.20	462.00 <sup>c</sup>	135.00	176.00	140.00	78.70	58.10	36.20	24.00	29.20	43.70
1975	141.00	34.70	56.80	39.70	--	--	27.40	14.00	9.98	--	10.60	16.40
1976	12.20	23.10	14.40	--	--	--	--	--	--	--	--	--
<b>SITE #3</b>												
1972	--	--	--	--	--	--	--	--	--	--	--	--
1973	18.40	41.70 <sup>a</sup>	24.20	24.00	40.40	42.00	25.80	25.70	38.20	21.50	18.50	25.60
1974	21.70	39.10	163.00 <sup>b</sup>	283.00 <sup>b</sup>	--	--	--	--	--	--	11.00	16.90
<b>SITE #4</b>												
1974	--	--	--	--	1460.00	738.00	1430.00	222.00	199.00	395.00	1240.00	710.00
1975	288.00	399.00	1850.00	254.00	139.00	684.00	118.00	146.00	72.20	189.00	188.00	128.00
1976	184.00	303.00	72.60	236.00	109.00	319.00	98.20	63.10	--	--	--	--

-- NO DATA

Errors are less than 20% except:

a -error between 20% and 100%

b -error greater than 100%

c -suspect, omitted from average

The levels of airborne plutonium at the downwind edge of the buffer zone (Indiana Street) were approximately the same level as reported at the monitoring station upwind from the plant. Although these levels were about twice that expected from background radioactivity in the Rocky Flats area, the effect of the spill area upon the off-site environment has been much reduced from earlier levels.

Comparison of the HASL data for 1976 for the Indiana Street location (site 2) with the 1975 data reported by the Rocky Flats Plant (Table 6-2) for the same general area shows the two networks to agree within a factor of about 2. The values reported by HASL range between 12 to 23 aCi/m<sup>3</sup>, while Rocky Flats reported an average of 37 aCi/m<sup>3</sup>.

#### 6.2.2 INHALATION DOSES DUE TO ON-SITE CONTAMINATION

An assessment can be made of the doses received through inhalation by individuals residing off-site at the time the measurements were made, based upon the considerable amount of air monitoring data available for the Rocky Flats Plant. In carrying out this assessment; a deliberate effort has been made to choose assumptions which are most likely to result in an overestimate of dose. These are:

- 1) Inhaled plutonium is considered to be in an insoluble form. (chemical solubility of an aerosol determines its residence time in the lung with insoluble compounds being retained the longest.)

- 2) The plutonium aerosol is assumed to have a lognormal distribution with an activity median aerodynamic diameter (AMAD) of 1 micrometer. (According to the ICRP (3) this implies that approximately 25% of the aerosol will be deposited in the pulmonary compartment of the lung. HASL (4) has reported 25% of

TABLE 6-2

PLUTONIUM IN AMBIENT AIR NEAR ROCKY FLATS PLANT (1976)  
 [Air Concentration in Attocuries/Cubic Meter]  
 Distances = 3 to 6 Kilometers

Station	Number of Samples Taken	Less Than Detectable	Volume (cubic meters)	Concentration	
				C <sub>maximum</sub>	C <sub>average</sub> <sup>a</sup>
S-31	12	1	461,547.0	0.144	<0.032 ± 96%
S-32	12	1	543,346.0	0.134	<0.035 ± 96%
S-33	12	1	531,886.0	0.097	<0.034 ± 95%
S-34	3	1	118,243.0	0.176	<0.037 ± 550%
S-35	3	0	119,322.0	0.116	0.027 ± 538%
S-36	2	0	57,286.0	0.012	0.012 ± 1734%
S-37	12	0	525,181.0	0.198	0.056 ± 93%
S-38	10	0	460,089.0	0.097	0.027 ± 108%
S-39	12	1	502,129.0	0.102	<0.026 ± 97%
S-40	12	0	486,876.0	0.198	0.054 ± 92%
S-41	12	1	472,698.0	0.136	<0.033 ± 99%
S-42	12	1	416,244.0	0.137	<0.037 ± 96%
S-43	11	1	360,818.0	0.185	<0.056 ± 105%
S-44	12	1	429,709.0	0.094	<0.029 ± 103%
Summary	137	9	5,485,374.0	0.198	-
Volume-Weighted Average					<0.037 ± 29%

<sup>a</sup>. Volume-weighted average.



the airborne activity being in the respirable range around Rocky Flats, while Sehmel (5) has reported a 20% respirable fraction.

3) The individual is considered to be exposed continuously for 10 years at the currently observed air concentration. (No further reduction in airborne activity as a result of weathering or remedial actions is assumed)

4) All plutonium was assumed to contribute to the dose, with no correction being made for ambient background levels of plutonium.

The PAID code developed by EPA (6) was used to calculate the annual dose rate. Tables 6-3 and 6-4 have been generated by the PAID code and relate years of exposure to the resultant dose rate for various organs. Values in the tables are normalized to an aerosol concentration of 1.0 femtocurie per cubic meter of air ( $\text{fCi}/\text{m}^3$ ) with a  $1 \mu\text{m}$  AMAD.

#### 6.2.3 INDIANA STREET LOCATION

Indiana Street is the nearest location to the Rocky Flats Plant where an individual in the general population could live and be exposed as a result of transuranium contamination originating from the Plant. This location is in the downwind direction of the prevailing winds that blow across the Rocky Flats Plant (7) and, therefore, it represents a worst case for offsite exposure.

From Figure 6-2 it can be seen that stations 5-35, 5-36, 5-37, 5-38, and 5-39 are located along Indiana Street. The station reporting the highest annual average for 1975 was 5-37 with  $0.056 \text{ fCi}/\text{m}^3$  (Table 6-2). Assuming this level to continue for the next 70 years, the 70th year dose rates to lung and bone can be calculated.

TABLE 6-3

ANNUAL DOSE RATE TO VARIOUS LUNG COMPARTMENTS  
FROM CHRONIC EXPOSURE TO PLUTONIUM-239 AEROSOLSConcentration: 1.0 fci/m<sup>3</sup>

Particle AMAD: 0.05, 1.0 and 5.0 Microns

Duration of Exposure (Years)	Pulmonary mrad/yr. x 10 <sup>-1</sup>			Tracheobronchial mrad/yr. x 10 <sup>-2</sup>			Nasopharyngeal mrad/yr. x 10 <sup>-6</sup>		
	0.05u	1.0u	5.0u	0.05u	1.0u	5.0u	0.05u	1.0u	5.0u
1	3.9	1.5	.7	2.7	1.1	6.1	.04	11.	30.
5	9.1	3.5	1.7	3.7	1.5	7.9	.04	11.	30.
10	9.8	3.8	1.8	3.8	1.6	8.1	.04	11.	30.
70	9.9	3.8	1.8	3.8	1.6	8.1	.04	11.	30.

TABLE 6-4

# ANNUAL DOSE RATES TO VARIOUS ORGANS FROM CHRONIC INHALATION OF TRANSURANIUM RADIONUCLIDES (In Millirad/Year)

Aerosol AMAD: 1  $\mu$ mConcentration: 1 fci/m<sup>3</sup> $f_1 = 10^{-3}$ 

Nuclides: Pu-239

Duration of Exposure	Liver	Skeletal	Bone Red Marrow	Endosteal	Liver	Skeletal	Bone Red Marrow	Endosteal
1 Year	1.0 E-3	3.0 E-4	4.0 E-4	6.4 E-3	1.4 E-4	3.0 E-7	4.4 E-7	3.8 E-6
5 Years	1.8 E-3	6.3 E-3	6.3 E-3	6.4 E-3	8.7 E-3	3.3 E-3	3.0 E-3	3.7 E-4
10 Years	3.3 E-3	1.9 E-3	1.8 E-3	3.3 E-3	4.4 E-4	1.7 E-4	1.4 E-4	2.0 E-3
15 Years	6.3 E-3	3.4 E-3	3.3 E-3	4.3 E-3	1.1 E-3	4.1 E-4	1.4 E-4	2.0 E-3
20 Years	1.3 E-1	4.9 E-3	3.4 E-3	6.3 E-3	1.9 E-3	7.1 E-4	4.4 E-4	2.0 E-3
30 Years	1.9 E-1	7.0 E-3	3.4 E-3	1.0 E-0	3.4 E-3	1.4 E-3	1.3 E-3	1.4 E-3
40 Years	2.4 E-1	1.1 E-1	1.1 E-1	1.3 E-0	6.4 E-3	2.3 E-3	2.0 E-3	2.4 E-3
50 Years	3.9 E-1	1.3 E-1	1.2 E-1	1.7 E-0	8.0 E-3	3.0 E-3	3.8 E-3	3.5 E-3
70 Years	3.6 E-1	1.7 E-1	1.6 E-1	2.3 E-0	8.0 E-3	4.4 E-3	4.1 E-3	3.1 E-3

Nuclides: Cm-240/Pu-240

Duration of Exposure	Liver	Skeletal	Bone Red Marrow	Endosteal	Liver	Skeletal	Bone Red Marrow	Endosteal
1 Year	1.3 E-3	3.0 E-4	4.6 E-4	3.0 E-3	1.4 E-3	6.0 E-4	3.4 E-4	6.4 E-3
5 Years	1.9 E-3	7.0 E-3	4.3 E-3	6.1 E-3	1.6 E-3	1.4 E-3	1.3 E-3	1.7 E-3
10 Years	3.3 E-3	2.1 E-3	1.9 E-3	3.0 E-3	4.7 E-3	1.7 E-3	1.6 E-3	1.8 E-3
15 Years	6.3 E-3	3.4 E-3	3.3 E-3	4.3 E-3	7.3 E-3	2.0 E-3	2.4 E-3	3.0 E-3
20 Years	1.3 E-1	5.3 E-3	4.0 E-3	6.0 E-3	9.4 E-3	3.7 E-3	3.4 E-3	3.9 E-3
30 Years	2.0 E-1	6.2 E-3	7.3 E-3	9.3 E-3	1.2 E-1	4.9 E-3	4.3 E-3	3.3 E-3
40 Years	2.4 E-1	1.1 E-1	1.0 E-1	1.3 E-0	1.4 E-1	5.7 E-3	5.3 E-3	4.1 E-3
50 Years	3.9 E-1	1.4 E-1	1.2 E-1	1.4 E-0	1.5 E-1	6.3 E-3	3.8 E-3	4.7 E-3
70 Years	3.7 E-1	1.0 E-1	1.7 E-1	2.1 E-0	1.6 E-1	6.8 E-3	6.3 E-3	7.3 E-3

\*Alpha dose only - 70th year beta dose rates: liver = 0.11 urad;  
bone = 0.019 urad.

# LOCATION OF OFF-SITE AMBIENT AIR SAMPLERS (8).

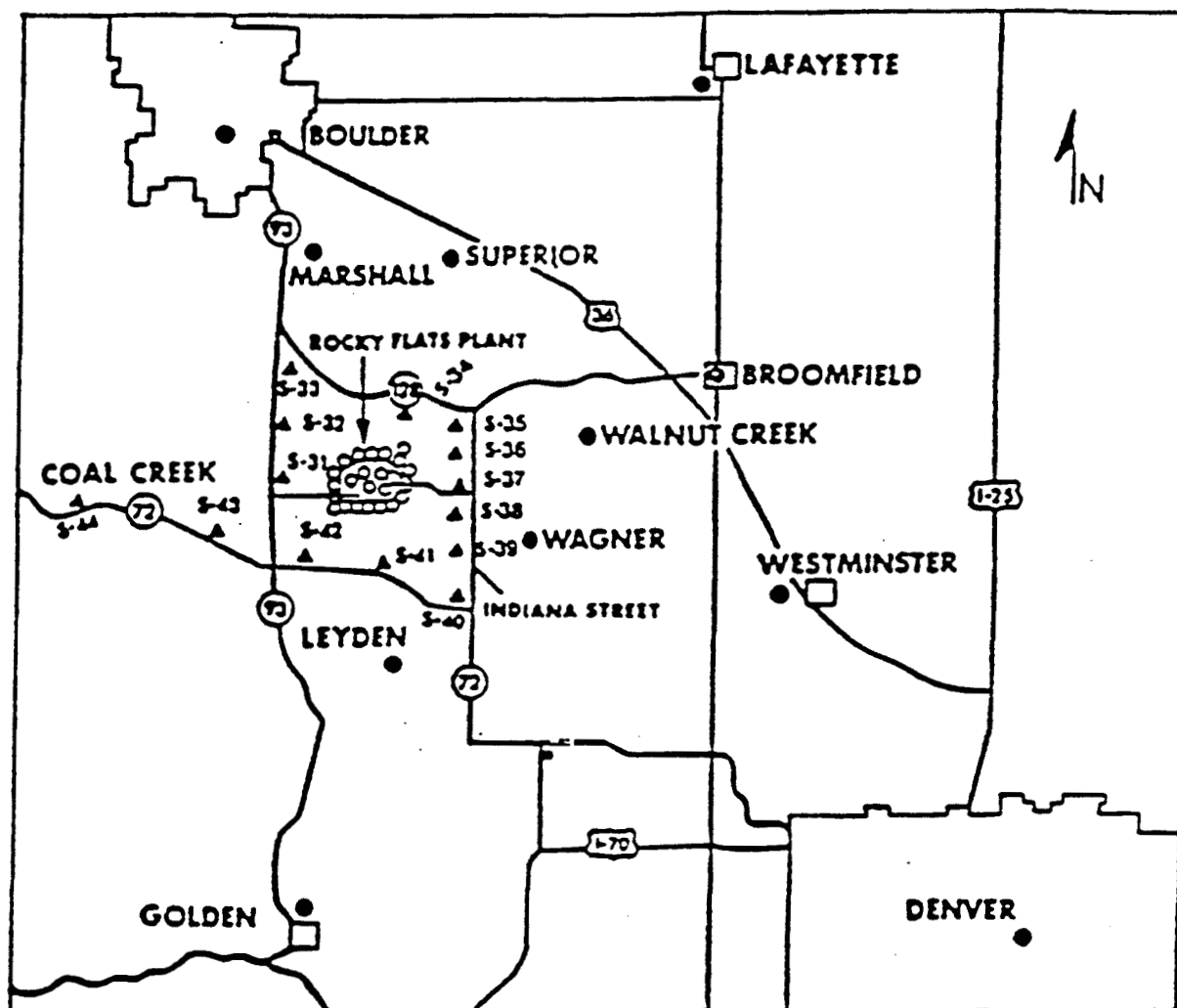


FIGURE 6-2

As shown in Table 6-3, an air concentration of  $1.0 \text{ fCi/m}^3$  for  $1 \mu\text{m}$  AMAD aerosols of Pu-239 would produce a 70th year dose rate to the pulmonary compartment of  $0.38 \text{ mrad/yr}$ ; therefore, proportionally, a concentration of  $0.056 \text{ fCi/m}^3$  (5-37) will produce a 70th yr dose rate of  $0.02 \text{ mrad/yr}$ . The bone dose rate associated with this level of Pu-239 according to Table 6-4 will be  $0.009 \text{ mrad/yr}$  in the 70th year.

Data on the air concentration of Am-241 have been reported by HASL (7) for the years 1970 through 1974. These data show the americium levels, measured at the perimeter fence of the Plant, to be approximately 11% of the Pu-239 levels. HASL projected that the Am-241 activity level will reach its maximum value arising from the decay of Pu-241 in the year 2033 at which time it will amount to 18% of the Pu-239 activity. For the calculation of the dose rate from Am-241, it is assumed that Am-241 is at the maximum of 18% of the Pu-239. The 70th year dose rate corresponding to a concentration of  $1 \text{ fCi/m}^3$  of Am-241 is  $0.4 \text{ mrad/yr}$ ; proportionally, an air concentration of  $0.18 \times 0.056 \text{ fCi/m}^3$  would produce  $0.004 \text{ mrad/yr}$  to the pulmonary compartment. The associated bone dose would be approximately  $0.002 \text{ mrad/yr}$ .

Based upon these calculations, the total pulmonary dose rate after 70 years of exposure for an individual living along Indiana Street would be  $0.024 \text{ mrad/yr}$ , while the associated bone dose would be  $0.01 \text{ mrad/yr}$ . Individuals living further away from the Rocky Flats Plant should receive even lower doses than these due to the lower air concentrations reported for the nearby communities.

#### 6.2.4 INHALATION DOSES DUE TO OFF-SITE CONTAMINATION

A complete assessment of the inhalation pathway for the Rocky Flats vicinity must consider the potential hazard from the low levels of contaminated soil which already exist off-site.

Questions have been raised as to the effect of this material in producing localized exposures which are not necessarily reflected in the data obtained through the air monitoring network around Rocky Flats. These inhalation exposures can arise through various mechanisms including: wind resuspension of contaminated soil, vehicular and mechanical disturbances of soil, accumulation and resuspension of dust within the home, as well as the resuspension of contaminated soil attached to clothing. The following analysis will attempt to investigate these exposure mechanisms and assess their potential impact.

#### 6.2.5 WIND RESUSPENSION

Figure 6-3 shows the off-site soil contamination contours reported by HASL in 1970 (2). Soil sampling programs in 1975 (8) showed that these contours had not changed significantly from the 1970 report. The highest off-site contour shown by the HASL data was  $0.05 \text{ uCi/m}^2$ . These contours were developed based upon an inventory sample to a depth of 20 centimeters. What is important in assessing the resuspension of soil, however, is only the material existing near the surface. Based upon the HASL soil depth profiles, Anspaugh (9) stated that approximately 20% of the total activity is contained within the first centimeter. Therefore, the highest contour value of  $0.05 \text{ uCi/m}^2$  would correspond to  $0.01 \text{ uCi/m}^2$  when corrected for a 1 cm. depth. On a mass basis,  $0.01 \text{ uCi/m}^2$  is equivalent to approximately 2 disintegrations per minute per gram of soil, i.e., 2 DPM/gm. The offsite area bounded by this contour is approximately two square kilometers and soil within that area would be projected to be at or above 2 DPM/gm. Beyond this area, off-site soil will generally be below this value.

This review uses the mass loading approach as an indicator of the general resuspension by wind over large land areas. Because of technical shortcomings identified with the mass



loading approach (10), the concept has been modified by an area correction factor to correct for small areas of contamination and with an enrichment factor to reflect a nonuniform distribution of radioactivity with soil particle size. This latter modification is particularly important because transuranium activity associated with soil particles within the respirable range is a greater hazard than it would be if associated with the larger particle sizes.

The mass loading approach assumes the loading of the air with particulates to be an index of resuspension and derives the airborne concentration of a specific radionuclide by a comparison with its concentration on the adjacent surface (11). Specifically,

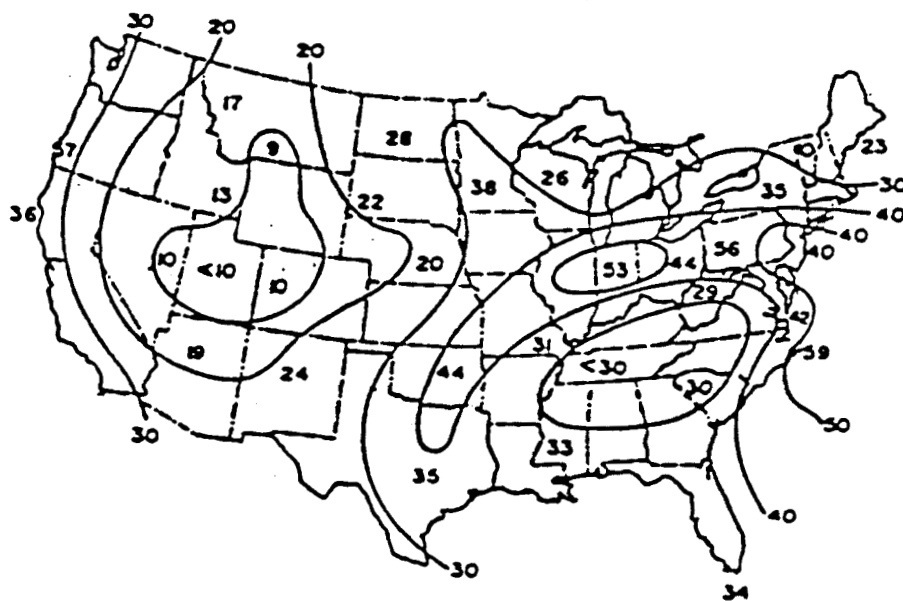
$$\text{Air Concentration (fCi/m}^3\text{)} = \frac{\text{Soil Concentration (uCi/m}^2\text{)}}{\text{Mass Loading (ug/m}^3\text{)} \times \text{U.C.}}$$

where U.C. is the units conversion factor based upon the depth of sampling and the soil density.

Airborne particulate mass loading is one of the criteria for clean air standards and measurements are widely available for urban and nonurban locations through the National Air Surveillance Network (NASN). The data recorded at nonurban stations are a better indicator of the levels of resuspended material than are urban measurements. In general, annual mean mass concentrations of airborne particulate material at the nonurban stations range from 5-50 micrograms per cubic meter (Figure 6-4); the mean arithmetic average for 1966 of all 30 nonurban NASN stations was 38 ug/m<sup>3</sup> (11). From Figure 6-4 an estimate can be made of the average mass loading for the general area in which Rocky Flats is located. It would appear that 15 ug/m is reasonably representative of this area on an annual basis.

Simple application of the mass loading approach without consideration of the activity distribution as a function of





**ANNUAL MEAN MASS CONCENTRATIONS ( $\mu\text{g}/\text{m}^3$ ) OF AIRBORNE PARTICLES FROM NON-URBAN STATIONS OF THE U.S. NATIONAL AIR SAMPLING NETWORK. 1964 - 1965**

**FIGURE 6-4**

particle size is not appropriate, however, since that would imply a uniform distribution of activity with particle size as well as a uniform resuspension of all particle sizes. This has not been found to be the case at Rocky Flats (12) or at other plutonium contaminated sites (13).

In addition, an important consideration in assessing the potential exposure due to contaminated soil is the amount of activity associated with particles within the respirable size range. Johnson (14) has suggested that sampling of only those particles in a soil sample which are within the inhalable size range (generally  $< 10 \mu\text{m}$ ) would give the best measure of risk to the public health around Rocky Flats. However, the weight fraction of particles in the less than  $10 \mu\text{m}$  range is small in most soils, and sampling, separation, and analysis techniques are correspondingly more difficult and inaccurate. There is also considerable evidence that some of the larger particles really consist of aggregates and are relatively easily broken down into smaller ones, so that an instantaneous measurement of a single size range may not give a good picture of long-term trends. Also a substantial contribution to other possible pathways (e.g. ingestion) may be via larger particle sizes and measurement of the contribution of only the inhalable fraction would not provide all the information that is required.

#### 6.2.5.1 ENRICHMENT FACTOR

The "Enrichment Factor" is intended to 1) give a mathematical view of the different fractions of the total radioactivity associated with particles of different size ranges, and 2) address the problem of the nonuniform resuspension of particle sizes.

The inhalable fraction of the soil is weighted by considering the relative distribution of activity and soil mass

as a function of particle size for representative samples of soil. To accomplish this, the sample of contaminated soil is segregated into "n" size increments and the activity and mass contained within each size increment is determined. The factor  $g_i$  is then defined as the ratio of the fraction of the total activity contained within an increment "i" to the fraction of the total mass contained within that increment. A value greater than 1 for  $g_i$  implies an enrichment of activity in relation to mass, while a value less than 1 indicates a dilution of the activity with respect to mass.

The nonuniform resuspension of particle sizes is also considered by measuring the mass loading as a function of particle size. The fraction of the airborne mass contained within each size increment "i" is then calculated and designated as  $f_i$ . The factors of  $f_i$  and  $g_i$  are then incorporated into the mass loading formulation for each size increment as follows:

$$\text{Air Conc}_i = \text{Air Mass Loading} \times f_i \times \text{Soil Conc} \times g_i$$

Summation over all the size increments results in the total air concentration:

$$\text{Air Conc} = \text{Air Mass Loading} \times \text{Soil Conc} \times \sum f_i g_i$$

The term  $\sum f_i g_i$  weights the contribution of plutonium from each soil size fraction to the total resuspended material, thereby taking into account both the nonuniform resuspension of particles sizes as well as the nonhomogeneous distribution of activity with particle size.

Data on the distribution of plutonium with soil particle size has been obtained (12) for the vicinity around Rocky Flats (Table 6-5). The ratio,  $g_i$  has been calculated for each size increment and indicates an enrichment of activity to mass associated with soil particles within the respirable size range. To obtain  $f_i$ , the data obtained by Chepil (15) for fields

# TABLE 6-5

EXPERIMENTAL DATA FOR WEIGHT AND ACTIVITY FRACTIONS  
FOR SOILS IN THE ENVIRONS OF THE ROCKY FLATS PLANT  
[Sampling and Analysis by US Environmental Protection Agency]

Sample	Size Increment (um)	Wgt Fract	Act Fract	$\frac{B_1}{f_1}$	$\frac{f_1}{f_1 B_1}$
RF 1A	2000-105	.62	.07	.12	2.34
	105-10	.18	.40	2.21	
	<10	.20	.53	2.65	
RF 1B	2000-105	.63	.39	.63	1.06
	105-10	.17	.06	.34	
	<10	.20	.55	2.74	
RF 1C	2000-105	.64	.43	.68	1.06
	105-10	.16	.07	.46	
	<10	.20	.49	2.47	
RF 2A	2000-105	.46	.13	.28	1.51
	105-10	.34	.37	1.10	
	<10	.20	.50	2.48	
av.					1.49

undergoing wind erosion in Colorado and Kansas were used. The results of his findings have been conveniently plotted by Slinn (16) and reproduced as Figure 6-5. Comparison of Chepil's data with another study substantiates the applicability to the Rocky Flats situation. Chepil found 30% of the airborne mass to be below 10  $\mu\text{m}$  versus a study by Willeke (17) in an area outside Denver where approximately 33% of the measured airborne mass was below 10  $\mu\text{m}$ . Values for  $f_i$  used in this analysis are included in Table 6-5.

#### 6.2.5.2 CORRECTION FOR AREA SIZE

Use of the mass loading approach implies that the air concentration is at equilibrium with the ground surface, i.e., a steady state situation exists in which the amount of material coming up from the surface is balanced by the rate at which material is depositing back onto the surface. In the strictest sense this limit can only be achieved for source areas approaching infinite dimensions. For sources of finite dimensions, a correction must be applied for area size.

Although many techniques are presently under development to calculate the air concentration arising from an area source, no generally accepted method has yet been identified. Usually, these approaches make use of a standard diffusion equation, modified to handle area sources. One such equation is the Sutton-Chamberlain diffusion equation:

$$\frac{X}{Q_A} = \frac{1}{V_d} \left[ \exp\left(-\frac{4 V_d D_1^2}{\pi^{1/2} C_z n u}\right) - \exp\left(-\frac{4 V_d D_2^2}{\pi^{1/2} C_z n u}\right) \right]$$

where  $X$  is the air concentration,  $\text{Ci}/\text{m}$

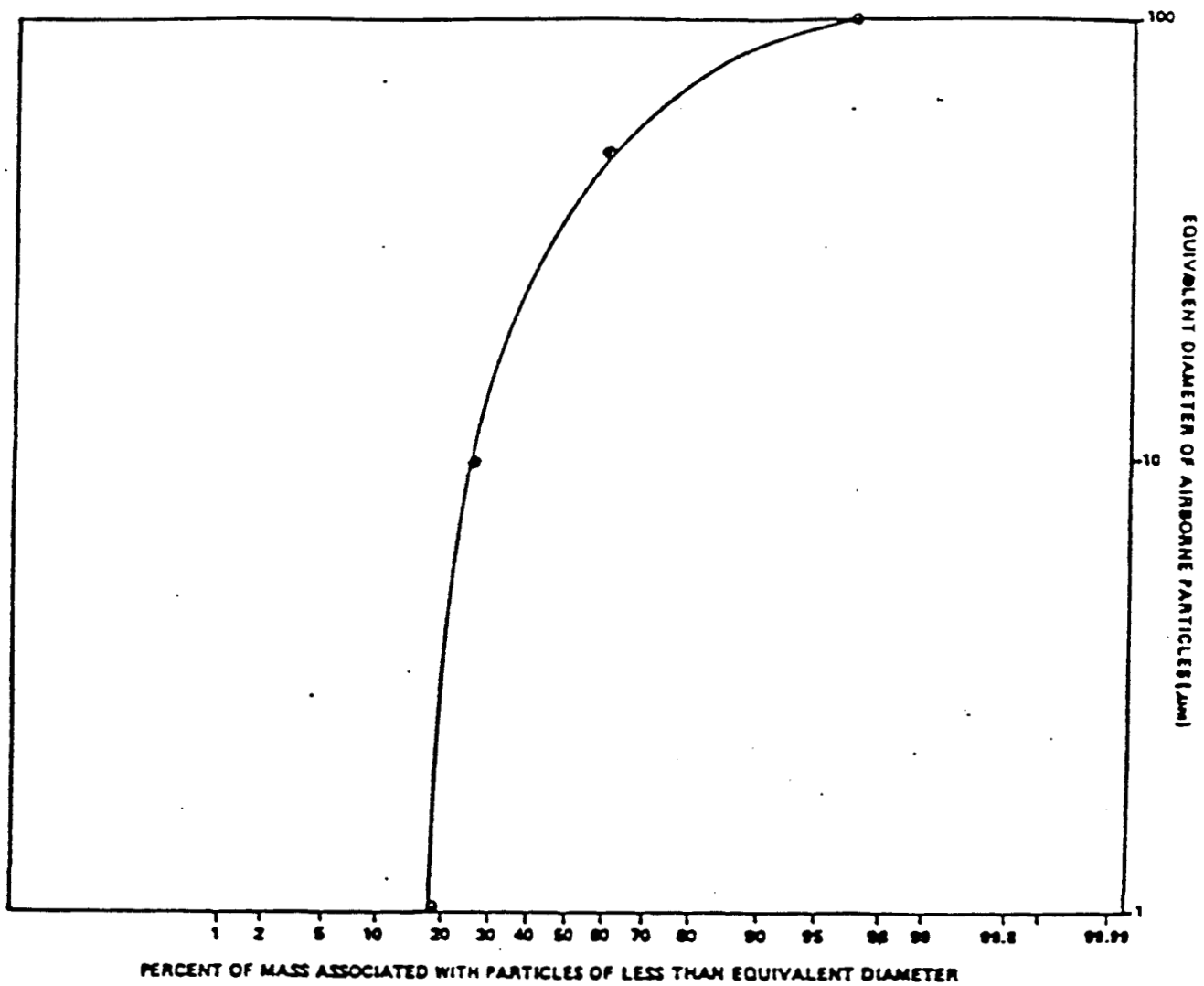
$Q$  is the amount of activity resuspended per unit area, per unit time,  $\text{Ci}/\text{m}^2 \text{ sec}$

$V_d$  is the particle deposition velocity,  $\text{m}/\text{sec}$

$D_1$  and  $D_2$  are the distances from the receptor to the nearest and furthest edges respectively of the source area

$u$  is average wind speed,  $\text{m}/\text{sec}$

$C_z$  and  $n$  are Sutton parameters for meteorological conditions.



PARTICLE SIZE DISTRIBUTION OF RESUSPENDED SOIL

FIGURE 6-5

For source areas approaching infinite depth,  $D_2 \rightarrow \infty$  and the above equation becomes

$$\frac{X}{Q_A} = \frac{1}{V_d}$$

Therefore, the correction term to be applied for areas of finite size is

$$1 - \exp\left(-\frac{4 V_d D_2^{n/2}}{\pi^{1/2} C_z n u}\right)$$

The area under consideration in this analysis has been described earlier. It is bounded by Indiana Street and the 0.05 Ci/m<sup>2</sup> isopleth (Figure 6-3) with a width in the downwind direction of approximately 1 kilometer. This is the most highly contaminated off-site area and includes sites of projected residential development. The meteorology for the Rocky Flats area has been described (8) to have neutral stability at least 50% of the time with a mean wind speed of 4.2 m/sec in 1975. Healy (18) has suggested values for the parameters required for the situation of neutral stability:  $C_z = 0.1$  and  $n = 0.25$ , while the ratio  $V_d/u$ , which depends upon the surface roughness, ranges between 0.003 and 0.008 for grassland. A value of 0.005 will be assumed. Therefore, the correction factor for the area under consideration is 0.66.

#### 6.2.6 AVERAGE AIR CONCENTRATION DUE TO WIND RESUSPENSION

The average soil concentration for the area is not known, but it would be somewhere between 0.05 uCi/m<sup>2</sup> and the next higher isopleth of 0.5 uCi/m<sup>2</sup>. For calculational purposes, 0.25 uCi/m<sup>2</sup> will be assumed or approximately 10 DPM/g (based upon 20% of the radioactivity within the first centimeter). By using the parameters developed in the previous sections for the Rocky Flats

area, one can estimate the average air concentration due to wind resuspension:

$$\text{Air Conc} = \text{Mass Loading} \times \text{Soil Conc} \times \text{Enrichment Factor} \\ \times \text{Area Correction Factor}$$

$$\begin{aligned} \text{Air Concentration} &= 15 \text{ ug/m}^3 \times 10 \text{ DPM/g} \times 10^{-6} \text{ g/ug} \\ &\quad \times \text{Ci}/2.22 \times 10^{12} \text{ DPM} \\ &= 0.066 \text{ fCi/m}^3 \end{aligned}$$

This calculated value of 0.066 fCi/m agrees within a factor of 2 with the data obtained for the sampling stations along Indiana Street.

Inherent in the above calculation were some conservative assumptions. First of all, the wind was assumed to be blowing 100% of the time across the contaminated area in the direction of the receptor. In reality, the reported (8) wind rose for Rocky Flats indicates that the wind blows from the westerly direction only about 50% of the time; the remaining time it will be blowing from the direction of less contaminated land and, therefore, less radioactivity would be available for resuspension. Second, in deriving the area correction factor the effect of breathing height was ignored with the ground level concentration being calculated. This is a conservative assumption since the airborne concentration will decrease as a function of the height above the ground. Although such refinements may be incorporated in the calculation, the results represent a conservative approach to deriving the dose rates to potentially exposed persons.

#### 6.2.7 RESUSPENSION OF SOIL BY MECHANICAL DISTURBANCES

The use of land contaminated with transuranium elements in the vicinity of Rocky Flats for agricultural or building purposes can result in localized resuspension and presents a potential inhalation hazard to individuals in the immediate vicinity of the



operation. In the vicinity of Rocky Flats, there is some farming of wheat and the raising of corn for livestock feed. Future development of the land for residential purposes is also being advocated. Although only a limited amount of experimental data are currently available to base an assessment of the inhalation hazard from such activities, some conclusions and recommendations can be made.

In assessing the agricultural situation, data obtained by Milham (19) have been utilized. In that study, a field contaminated with plutonium near the Savannah River Facility was subjected to various plowing and seeding activities associated with planting wheat. The increase in the airborne activity above that from normal wind resuspension was monitored at the location of the tractor operator and at the downwind edge of the field during the various activities. An average increase of a factor of 30 was observed in the level of resuspended plutonium at the location of the tractor operator and an increase of a factor of 5 at the edge of the field. Based upon these observations, the average air concentration for the year can be calculated for these two locations, assuming that the field is cultivated 30 days of the year for 8 hours per day. Again the area under consideration will be that area of highest off-site contamination described earlier with an average soil contamination level of 10 DPM/g. In the previous discussion of wind resuspension, this level of soil activity produced an air concentration of 0.066 fCi/m<sup>3</sup>. From Milham's data, this activity level would increase to 2.0 fCi/m<sup>3</sup> at the location of the tractor operator and to 0.33 fCi/m<sup>3</sup> at the edge of the field during the agricultural operations. The annual average concentration at the tractor location is then:

$$2 \text{ fCi/m}^3 \times 8/24 \text{ hr} \times 30/360 \text{ d} + 0.33 \text{ fCi/m}^3 \times 330/360 \text{ d} \\ + 0.066 \text{ fCi/m}^3 \times 16/24 \text{ hr} \times 30/360 \text{ d} = 0.07 \text{ fCi/m}^3$$

When these annual Pu-239 concentrations are compared to the value of  $2.6 \text{ fCi/m}^3$  which was calculated by the PAID code to correspond with a dose rate of  $1 \text{ mrad/year}$  to the lung, one can conclude that agricultural operations in the area of Rocky Flats would produce activity levels well below levels of concern. In addition, after the first plowing cycle, the surface concentration should be diluted by mixing with soil from below the surface and subsequent plowings would produce air concentration lower than that of the first year.

One can also make projections for building activities based upon the agricultural situation examined above. There does not appear to be any reason why building activities, such as excavation and grading, should produce higher instantaneous air concentrations than those observed during agricultural plowing and, therefore, should not present a more restrictive situation.

#### 6.2.8 RESUSPENSION OF DUST WITHIN THE HOME

The total amount of soil continuously in the home is not known but an assumption of  $10 \text{ g/m}^3$  has been made (20). This amounts to about 3 lbs of soil in a modest 1500 square foot house. Because the floors are harder and smoother than outside surfaces, the resuspension from these surfaces will be higher. Resuspension factors of  $10^{-6}/\text{m}$  have been used in the past to predict exposures in the work place and studies of  $\text{PuO}_2$  deposited on indoor surfaces have been consistent with such a value (21).

The following exposure situation is postulated: the individual is exposed to contaminated dust in the home for 24 hrs/day, 7 days/week, for 70 years. The dust in the home has the same activity/gram as outside soil and has an areal distribution within the home of  $10 \text{ g/m}^2$ . The air concentration resulting from resuspended dust at  $10 \text{ DPM/g}$  would be:

$$10 \text{ DPM/g} \times \text{Ci}/2.22 \times 10^{12} \text{ DPM} \times 10 \text{ g/m}^2 \times 10^{-6}/\text{m} = 0.045 \text{ fCi/m}^3$$

## **APPENDIX G**

### **REAL TIME INSTRUMENT CALIBRATION AND DATA SHEETS**

# DIRECT READING INSTRUMENT LOG

object: \_\_\_\_\_

Job No. \_\_\_\_\_

Date: \_\_\_\_\_

**Operation:** \_\_\_\_\_

**Instrument:** \_\_\_\_\_

Calibration: \_\_\_\_\_  
Amt, Component, Date

**Sampling Technique:** \_\_\_\_\_

**Sample Interval:** \_\_\_\_\_

**Background Reading:**

**Action Level/Response:** \_\_\_\_\_

[illegible]

Project Name: \_\_\_\_\_

Job Number: \_\_\_\_\_

Instrument: \_\_\_\_\_

Serial: \_\_\_\_\_

20484\080392.RPT

## **APPENDIX H**

### **PERSONAL SAMPLING CALIBRATION AND DATA SHEETS**



# AIR SAMPLE DATA SHEET

DATE: 10/25/71 JAA

FILE NAME: FORMS\FORM-A01.DWG

[illegible]



**APPENDIX I**  
**SAFETY BRIEFING LOG**

## SITE SAFETY BRIEFINGS

Job Name \_\_\_\_\_ Number \_\_\_\_\_

Date \_\_\_\_\_ Start Time \_\_\_\_\_ Completed \_\_\_\_\_

Site Location \_\_\_\_\_

.....

### SAFETY ISSUES

Tasks (this shift) \_\_\_\_\_

Protective Clothing/Equipment \_\_\_\_\_

Chemical Hazards \_\_\_\_\_

Physical Hazards \_\_\_\_\_

Control Methods \_\_\_\_\_

Special Equipment/Techniques \_\_\_\_\_

Nearest Phone \_\_\_\_\_

Hospital Name/Address \_\_\_\_\_

Special Topics (incidents, action taken, etc.) \_\_\_\_\_

\_\_\_\_\_

.....

### ATTENDEES

Print Name

Sign Name

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
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\_\_\_\_\_  
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\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Meeting conducted by: \_\_\_\_\_

**APPENDIX J**  
**MATERIAL SAFETY DATA SHEETS**

# Colorado Silica Sand, Inc.

3250 Drennan Industrial Loop

P.O. Box 15615

Colorado Springs, CO 80935

Phone (719) 390-7969

TWX: 910-920-4992

FAX: (719) 390-5517

## MATERIAL SAFETY DATA SHEET

### SECTION I - PRODUCT IDENTIFICATION

**IDENTITY:** Crystalline Silica (Quartz)  
**MANUFACTURER'S NAME:** Colorado Silica Sand, Inc.  
**ADDRESS:** 3250 Drennan Industrial Loop  
P.O. Box 15615  
Colorado Springs, CO 80935  
**EMERGENCY  
TELEPHONE NUMBER:** (719) 390-7969  
**TELEPHONE NUMBER  
FOR INFORMATION:** (719) 390-7969  
**DATE REVISED:** August 31, 1990  
**REPLACES:** September 12, 1988

### SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

**HAZARDOUS COMPONENTS:** Silica, Crystalline Quartz (respirable)  
**CHEMICAL NAME:** Silicon Dioxide  $\text{SiO}_2$   
**FAMILY OR COMMON NAMES:** Silica sand; quartz; flint; sand; crystalline silica; free silica (a natural mineral extracted from the earth)  
**CHEMICAL ABSTRACT SERVICE NO.:** 14808-60-7  
**TRADE NAME:** See Attachment A  
**OSHA PERMISSIBLE EXPOSURE LIMIT (PEL):** Exposure to airborne crystalline silica sand shall not exceed an 8-hour time-weighted average limit as stated in 29 CFR Section and Numbered Clause 1910.1000 specifically "Silica: Crystalline: Quartz (respirable) PEL - TWA = 0.1 Mg/M3

Crystalline Quartz (respirable)

Mppcf  
250  
 $\% \text{SiO}_2 + 5$

Mg/M3  
10mg/M3  
 $\% \text{SiO}_2 + 2$   
30mg/M3  
 $\% \text{SiO}_2 + 2$

Quartz (Total Dust)

**ACGIH TLV (Threshold Limit Value):**

Crystalline Quartz  
TLV-TWA 0.1 mg/M3 (Respirable Dust)  
See Threshold Limit Value & Biological Exposure Indices for 1987-1988 - American Conference of Governmental Industrial Hygienists.

**MSHA TLV (Threshold Limit Value):**

Exposure to airborne crystalline silica shall not exceed an 8-hour time-weighted average limit as stated in MSHA Standards, Subpart D, Section 56.5001 on Air Quality specifically "Silica: Crystalline: Quartz (respirable)

Mg/M3  
10 mg/M3  
 $\% \text{SiO}_2 + 2$

Crystalline Quartz (respirable)

**OTHER LIMITS RECOMMENDED:**

National Institute for Occupational Safety and Health (NIOSH). Recommended standard maximum permissible concentration = 0.05 mg/M3 (respirable free silica) as determined by a full-shift sample up to 10-hour working day, 40-hour work week. See NIOSH Criteria for a Recommended Standard Occupational Exposure to Crystalline Silica.

### SECTION III - PHYSICAL & CHEMICAL CHARACTERISTICS

APPEARANCE AND ODOR: Sand - granular, crushed or ground. No odor or taste.  
COLOR: Tan or white  
BOILING POINT: 4046 F.  
SPECIFIC GRAVITY: (H<sub>2</sub>O = 1): 2.65.  
SOLUBILITY IN WATER: Insoluble  
MELTING POINT: 3000 F.  
VAPOR PRESSURE (mmHg at 20 C): None  
VAPOR DENSITY (Air = 1): None  
EVAPORATION RATE: (Butyl Acetate = 1): None

### SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT: Non Flammable  
FLAMMABLE LIMITS: None  
LEL: None  
UEL: None  
FIRE EXTINGUISHING MATERIALS: N/A  
USUAL FIRE AND EXPLOSION HAZARDS: None  
SPECIAL FIRE FIGHTING PROCEDURES: None

### SECTION V - REACTIVITY DATA

STABILITY: Stable (Inert - Neutral - Non-Reacting)  
INCOMPATIBILITY  
(MATERIALS TO AVOID): Contact with powerful oxidizing agents such as fluorine, chlorine, trifluoride manganese trioxide, and oxygen difluoride may cause fires. Silica will dissolve in hydrofluoric acid (HF) and produce a corrosive gas, silicon tetrafluoride (SiF<sub>4</sub>).

#### HAZARDOUS DECOMPOSITION PRODUCTS INCLUDING COMBUSTION PRODUCTS:

None

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Generation of respirable quartz particles.

### SECTION VI - HEALTH HAZARD INFORMATION:

ROUTES OF ENTRY: Inhalation: Yes; Skin: No; Ingestion: No  
HEALTH HAZARDS:  
(Acute and Chronic) Excessive inhalation of dust may result in respiratory disease, including silicosis, pneumoconiosis and pulmonary fibrosis. Acute or rapidly developing silicosis may occur in a short period of time in heavy exposure in certain occupations such as sandblasters. Silicosis is a form of disabling pulmonary fibrosis which can be progressive and may lead to death. Be sure to maintain current physicals. The International Agency of Research on Cancer (IARC) has evaluated in Volume 42, Monographs on the Evaluation of the Carcinogenicity Risk of Chemicals to Humans, Silica and Some Silicates (1987), that there is "sufficient evidence for the carcinogenicity of crystalline silica to experimental animals" and "limited evidence" with respect to humans.

#### SIGNS AND SYMPTOMS OF OVEREXPOSURE:

INHALED: Undue breathlessness, coughing, sputum production, and reduced pulmonary function.  
CONTACT WITH SKIN OR EYES: Irritation.  
ABSORPTION THROUGH SKIN: Not Applicable.  
SWALLOWED: May cause nausea.

## **CARCINOGENICITY:**

NPT: No

IARC MONOGRAPHS: Yes - Level 2A Grouping.

OSHA REGULATED: Not as a carcinogen.

## **MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:**

Individuals with pulmonary or respiratory disease such as asthma, bronchitis and emphysema should avoid prolonged exposure of silica dust. Pulmonary functions may be reduced by inhalation of respirable crystalline silica. Also lung scarring produced by such inhalation may lead to a massive fibrosis of the lung which may aggravate other pulmonary conditions and diseases and which increases susceptibility to pulmonary tuberculosis. Massive fibrosis may be accompanied by the right heart enlargement, heart failure, and pulmonary failure. Smoking aggravates the effects of exposure.

## **EMERGENCY FIRST AID PROCEDURES:**

For sand in eyes, wash immediately with water. If irritation persists, seek medical attention. For inhalation, remove person to fresh air, give artificial respiration as needed, seek medical attention as needed. If swallowed, do not induce vomiting. Vomiting may be fatal if breathed into lungs. Seek medical attention.

## **SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE**

### **STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:**

Use dustless methods (vacuum) and place into closable container for disposal, or flush with water. Do not dry sweep. Wear protective equipment. Avoid generating airborne respirable dust.

**WASTE DISPOSAL METHOD:** If uncontaminated, dispose as an inert, non-metallic mineral. If contaminated, use appropriate method in accordance with Federal, State and Local laws.

**PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:** Avoid spillage. Use dustless systems for handling and employ engineering controls to reduce concentration of airborne dust.

**OTHER PRECAUTIONS:** Use dustless systems for handling, storage, and cleanup so that airborne dust does not exceed the PEL. Use adequate ventilation and dust collection. Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain good housekeeping. Maintain, clean, and fit test respirators in accordance with OSHA regulations. Maintain and test ventilation and dust collection equipment. Wash or vacuum clothing which has become dusty. We recommend that smoking be prohibited in all areas where respirators must be used.

**WARN YOUR EMPLOYEES (AND YOUR CUSTOMER-USERS IN CASE OF RE-SALE) BY POSTING AND OTHER MEANS OF THE HAZARD AND OSHA PRECAUTIONS TO BE USED. PROVIDE TRAINING FOR YOUR EMPLOYEES ABOUT THE OSHA PRECAUTIONS.**

See OSHA Hazard Communications Rule 29 CFR Sections 1910.1200, 1915.99, 1917.26, 1918.90, 1926.59, and 1926.21, and State and Local Worker of Community "Right to Know" laws and regulations.

See American Society for Testing and Materials (ASTM) standard practice E1132.86, "Standard Practice for Health Requirements Relating to Occupational Exposure to Quartz Dust."

See the most recent standards of the American National Standard Institute (ANSI Z.88.2), and the Mine Safety and Health Administration (MSHA) (30 CFR Part 56).

## **SECTION VIII - CONTROL MEASURES**

### **RESPIRATORY PROTECTION (type):**

Use conventional particulate respiratory protection based on consideration of airborne concentrations and duration of exposure. See most recent standards of the American National Standard Institute (ANSI Z.88.2), the Occupational Safety and Health Administration (OSHA) (29 CFR Part 1910.134) and the Mine Safety and Health Administration (MSHA) (30 CFR Part 56). Use NIOSH or MSHA approved respiratory protection for respirable quartz under appropriate OSHA standards and regulations. Supplied air types recommended.

### **VENTILATION AND ENGINEERING CONTROLS:**

Use sufficient local exhaust to reduce the level of respirable crystalline silica to the PEL. See ACGIH "Industrial Ventilation - A Manual of Recommended Practice" the latest edition.

### **EYE PROTECTION (type):**

Wear protective safety glasses at all time.

**PROTECTIVE GLOVES:** When exposed to hot product.

**OTHER CLOTHING & EQUIPMENT:** Provide eye wash. Monitor respirable quartz levels in workplace regularly.

**WORK PRACTICES, HYGIENIC PRACTICES:** Minimize dust generation. Clean up spills promptly. Train all employees on handling product before they work with it.

**OTHER HANDLING AND STORAGE REQUIREMENTS:** Protect containers from physical damage. Handle with minimum dust generation. Do not reuse containers.

## **SECTION IX - TRANSPORTATION**

**DOT HAZARD CLASSIFICATION:** None

**PLACARD REQUIRED:** None

**LABEL REQUIRED:** Label as required by the OSHA Hazard Communication standard [29 CFR - 1910.1200 (f)], and applicable state and local regulations.

This form has been completed to meet all current state and federal (OSHA) regulations, but is offered without guarantee. Our company expressly disclaims all applications beyond our control. The data in this material safety data sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process. The information set forth herein is based on technical data that Colorado Silica Sand, Inc. believes reliable. It is intended for use by persons having technical skills and at their own discretion and risk. Since conditions of use are outside our control, we make no warranties, expressed or implied, and assume no liability in connection with any use of this information. Nothing herein is to be taken as a license to operate under or a recommendation to infringe any patents. Any use of this data and information must be determined by the user to be in accordance with federal, state, and local laws and regulations. Customers and users of silica must comply with all applicable health and safety laws, regulations, and orders.

### **COLORADO SILICA SAND, INC. ATTACHMENT "A" COLORADO SANDS**

#### **FRAC SAND & WATER WELL GRAVEL PACK**

4-6	16-30
4-8	16-40
6-8	20-40
8-12	32-42
8-14	40-60
8-16	100 Mesh
10-20	

#### **OIL WELL GRAVEL PACK**

4-8	14-20
6-8	16-20
8-12	16-30
10-14	20-30
10-16	20-40
10-20	30-40
12-18	40-60

#### **BLAST SAND GRIT**

# 10  
# 16  
# 20  
# 30  
# 70

**STUCCO SAND  
FINES BLEND  
FOUNDRY SAND  
FILTER MEDIA SAND  
PIPELINE SAND**

**ENGINE SAND  
TOP DRESSING  
SAND TRAP I  
SAND TRAP II  
SAND TRAP III  
MARK IV**

#### **TEXAS RESCREENED SANDS**

6-9	16-20
8-12	10-30
8-16	20-30

# Baroid Environmental, Safety and Transportation Data Sheet



## AQUAGEL® GOLD SEAL®

### I. PRODUCT IDENTIFICATION

<b>SUPPLIER</b> BAROID DRILLING FLUIDS, INC.	<b>REGULAR TELEPHONE NUMBER</b> 713 987-5900 <b>EMERGENCY TELEPHONE NO.</b> 713/987-4000
<b>ADDRESS</b> P.O. BOX 1675 HOUSTON, TEXAS 77251	
<b>TRADE NAME</b> AQUAGEL GOLD SEAL	
<b>GENERIC DESCRIPTION</b> WYOMING BENTONITE, SODIUM MONTMORILLONITE CAS #1302-78-9	

### II. HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	%	HAZARD DATA
SILICA 14808-60-7	2-6%	LOW CONCENTRATIONS OF
		CRYSTALLINE SILICA(SIO <sub>2</sub> )
		IN THE FORM OF QUARTZ,
		CRISTOBALITE,AND TRIDYMIT
		MAY BE PRESENT
		(SEE SECTION V)

### III. PHYSICAL DATA

<b>BOILING POINT (Deg F)</b> NA	<b>MELTING POINT</b> ND	<b>FREEZING POINT</b> ND
<b>SPECIFIC GRAVITY (H<sub>2</sub>O = 1)</b> 2.5	<b>VAPOR PRESSURE (mm Hg)</b> NA	
<b>VAPOR DENSITY (AIR = 1)</b> NA	<b>SOLUBILITY IN WATER, % BY WT.</b> NA	
<b>% VOLATILES BY VOLUME</b> NA	<b>EVAPORATION RATE(BUTYL ACETATE = 1)</b> NA	
<b>APPEARANCE AND ODOR</b> LIGHT TAN TO GRAY POWER, NO ODOR	<b>DENSITY @ 20 Deg C (Uncompacted)</b> 49.4 LBS/	
<b>pH</b> NA		

NA - Not Applicable ND - Not Determined

All information recommendations and suggestions herein concerning our product are based on tests and data believed to be reliable, however, it is the user's responsibility to determine the safety, toxicity, and suitability for his own use of the product described herein. Since the actual use by others is beyond our control, no guarantee, expressed or implied, is made by Baroid Corporation as to the effects of such use, the results to be obtained, or the safety and toxicity

of the product nor does Baroid Corporation assume any liability arising from the use, by others, of the product referred to herein. Nor is the information herein to be construed as absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances arise or because of applicable laws or government regulations.



**IV. FIRE AND EXPLOSION DATA**

AQUAGEL GOLD SEAL IS NOT FLAMMABLE AND NOT EXPLOSIVE, DOES NOT SUPPORT COMBUSTION.  
EXTINGUISHING MEDIA: WATER

**V. HEALTH HAZARD INFORMATION**

CARCINOGENICITY - SEE ROUTES OF EXPOSURE AND EFFECTS (BELOW)

ACUTE ORAL LD50  
ND

ACUTE DERMAL LD50  
ND

AQUATIC TOXICITY LC50  
ND

**ROUTES OF EXPOSURE AND EFFECTS**

THIS PRODUCT CONTAINS FREE CRYSTALLINE SILICA WHICH ACCORDING TO THE IARC HAS EXHIBITED LIMITED EVIDENCE OF CARCINOGENICITY IN HUMANS. PROLONGED INHALATION OF THE POWDER MAY RESULT IN SILICOSIS, A NONCANCEROUS LUNG DISEASE. OSHA FINAL LIMITS TWA - 01. mg/m<sup>3</sup>. IF CRISTOBALITE OR TRIDYMITTE IS DETECTED, USE ONE HALF THE VALUE CALCULATED FROM FORMULA FOR QUARTZ.

EYES: IRRITANT SKIN: POTENTIAL IRRITANT INHALATION: IRRITATION TO LUNGS, NOSE, AND THROAT; PROLONGED INHALATION MAY CAUSE LUNG INJURY OR DISEASE.

**EMERGENCY AND FIRST AID PROCEDURES**

WASH AREAS OF CONTACT WITH SOAP AND WATER.  
FLUSH EYES WITH LARGE AMOUNT OF WATER FOR AT LEAST 15 MINUTES.

**VI. REACTIVITY DATA****CONDITIONS CONTRIBUTING TO INSTABILITY**

THIS PRODUCT IS STABLE UNDER NORMAL DRILLING CONDITIONS.

**INCOMPATIBILITY**

NONE

**HAZARDOUS DECOMPOSITION PRODUCTS**

NONE

**CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION**

NONE

**VII. SPILL OR LEAK PROCEDURES****STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED**

NORMAL HOUSEKEEPING, CAUSES SLIPPERY SURFACES WHEN WET.

**NEUTRALIZING CHEMICALS**

NA

**WASTE DISPOSAL METHOD**

DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REGULATIONS

**VIII. INDUSTRIAL HYGIENE CONTROL MEASURES****VENTILATION REQUIREMENTS**

MECHANICAL, GENERAL ROOM VENTILATION

USE LOCAL VENTILATION TO MAINTAIN TLV (SEE SECTION V)

**SPECIFIC PERSONAL PROTECTIVE EQUIPMENT****RESPIRATORY**

USE A NIOSH APPROVED MECHANICAL FILTER RESPIRATOR FOR NON TOXIC DUSTS.

**EYE**

NONE REQUIRED

**GLOVES**

NONE REQUIRED

**OTHER CLOTHING AND EQUIPMENT**

APRON, EYEWASH STATION

**IX. SPECIAL PRECAUTIONS****PRECAUTIONARY STATEMENTS**

AVOID PROLONGED INHALATION.  
RECOMMENDED LABELING:  
FRONT PANEL: CAUTION  
SEE BACK PANEL FOR CAUTION BEFORE USE.  
BACK PANEL: CAUTION  
THIS PRODUCT CONTAINS FREE CRYSTALLINE SILICA WHICH  
ACCORDING TO THE IARC HAS EXHIBITED LIMITED EVIDENCE OF  
CARCINOGENICITY IN HUMANS. PROLONGED INHALATION OF THE  
POWDER MAY RESULT IN SILICOSIS, A NONCANCEROUS LUNG  
DISEASE. AVOID CREATING DUSTY CONDITIONS AND USE A NIOSH  
APPROVED DUST RESPIRATOR.

**OTHER HANDLING AND STORAGE REQUIREMENTS**

STORE IN SHELTERED AREA, OR COVER FOR MOISTURE PROTECTION.

**X. DEPARTMENT OF TRANSPORTATION INFORMATION**

PROPER SHIPPING NAME :  
NOT REGULATED

PLACARDS :  
NONE

HAZARD CLASS :  
NOT HAZARDOUS

REPORTABLE QUANTITY :  
NONE

HAZARDOUS SUBSTANCE :  
NONE

ID NUMBER :  
NONE

LABEL :  
NONE

**XI. REGULATORY INFORMATION****STATUS ON SUBSTANCE LISTS**

Comprehensive Environmental Response, Compensation and Liability Act of 1980, (CERCLA) requires notification of the National Response Center of release of quantities of Hazardous Substances equal to or greater than the reportable quantities (RQs) in 40 CFR 302.4.

Components present in this product which may require notification are:

Chemical	CAS Number
NONE	

Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III requires emergency planning based on Threshold Planning Quantities (TPQs) and release reporting based on RQs.

Components present in this product at a level which could require reporting under the statute are:

NONE

SARA requires the submission of annual reports of toxic chemicals that appear in 40 CFR 372 (for SARA 313). This information must be included in all MSDS that are copied and distributed for this material.

Components present in this product at a level which could require reporting under the statute are:

NONE

Toxic Substances Control Act (TSCA)

The ingredients of this product are on the TSCA inventory.

**XII. STATE RIGHT TO KNOW**

QUARTZ IS ON CANADIAN WHMIS (WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM) INGREDIENT DISCLOSURE LIST, MASSACHUSETTS SUBSTANCE LIST, NEW JERSEY RIGHT TO KNOW HAZARDOUS SUBSTANCE LIST AND PENNSYLVANIA HAZARDOUS SUBSTANCE LIST.

RECEIVED OCT 08 1992



Material Safety Data Sheet  
May be used to comply with  
OSHA's Hazard Communication Standard,  
29 CFR 1910.1200. Standard must be  
consulted for specific requirements.

U.S. Department of Labor  
Occupational Safety and Health Administration  
(Non-Mandatory Form)  
Form Approved  
OMB No. 1218-0072

IDENTITY (As Used on Label and List)	AQUASET	Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.
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Section I

Manufacturer's Name Fluid Tech, Inc.	Emergency Telephone Number (702) 871-1884
Address (Number, Street, City, State, and ZIP Code) 4335 West Tropicana Suite #3	Telephone Number for Information (702) 871-1884
Las Vegas, NV 89103	Date Prepared 11/15/87
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Mineral Dusts Total Dust	15 mg/m3	10 mg/m3*		
including low conc. Resp Dust	5 mg/m3	5 mg/m3*		
of crystalline silica				
*From 1986 ACGIH Hand Book as inert nuisance dust				

Section III — Physical/Chemical Characteristics

Boiling Point	NA	Specific Gravity (H <sub>2</sub> O = 1)	Bulk Density	72# ft <sup>3</sup>
Vapor Pressure (mm Hg.)	NA	Melting Point	Approx.	1400 °C
Vapor Density (AIR = 1)	NA	Evaporation Rate (Butyl Acetate = 1)		NA
Solubility in Water Insoluble				
Appearance and Odor Light gray to tan odorless, dry granules				

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	NA	Flammable Limits	NA	LEL	NA	UEL	NA
Extinguishing Media NA							
Special Fire Fighting Procedures NA							
Unusual Fire and Explosion Hazards NA							



# Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	None
	Stable	X		

Incompatibility (Materials to Avoid) Hydrofluoric Acid

Hazardous Decomposition or Byproducts None

Hazardous Polymerization	May Occur		Conditions to Avoid	None
	Will Not Occur	X		

# Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic) Acute (short term exposure): cough if exposed to dust levels higher than TLV's. Chronic (long term exposure): may lead to development of silicosis if constantly exposed to dust levels higher than TLV's.

Carcinogenicity: NTP? not listed IARC Monographs? not listed OSHA Regulated? No

Signs and Symptoms of Exposure Long term exposures to dust in excess of TLV's may lead to silicosis

Medical Conditions Generally Aggravated by Exposure Any respiratory illness

Emergency and First Aid Procedures Remove affected personnel from dusty area to clean air

# Section VII — Precautions for Safe Handling and Use.

Steps to Be Taken in Case Material is Released or Spilled Avoid breathing dust, use respirator approved for silica bearing dust. Vacuum or sweep up dust.

Waste Disposal Method Dispose of in sanitary landfill

Precautions to Be Taken in Handling and Storing Use NIOSH/MSHA approved respirators for silica bearing dust when dust levels exceed TLV's.

Other Precautions If wet down on floors, material will become slippery.

# Section VIII — Control Measures

Respiratory Protection (Specify Type) NIOSH/MSHA approved for silica bearing dusts

Ventilation	Local Exhaust	Yes, if practical	Special	None
	Mechanical (General)	NA	Other	NA

Protective Gloves Not necessary Eye Protection Safety glasses

Other Protective Clothing or Equipment None

Work/Hygiene Practices Good housekeeping as for any inert dusty material

Material Safety Data Sheet  
May be used to comply with  
OSHA's Hazard Communication Standard,  
29 CFR 1910.1200. Standard must be  
consulted for specific requirements.

U.S. Department of Labor  
Occupational Safety and Health Administration  
(Non-Mandatory Form)  
Form Approved  
OMB No. 1218-0072



IDENTITY (As Used on Label and List)

AQUASET II

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name Fluid Tech, Inc.	Emergency Telephone Number (702) 871-1884
Address (Number, Street, City, State, and ZIP Code) 4335 West Tropicana Suite #3	Telephone Number for Information (702) 871-1884
Las Vegas, NV 89103	Date Prepared 11/15/87
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Mineral Dusts	Total dust 15 mg/m <sup>3</sup>	10 mg/m <sup>3</sup> *		
including low conc.	Resp. dust 5 mg/m <sup>3</sup>	5 mg/m <sup>3</sup> *		
of crystalline silica				

\*From 1986 ACGIH Hand book as inert nuisance dust.

Section III — Physical/Chemical Characteristics

Boiling Point	NA	Specific Gravity (H <sub>2</sub> O = 1)	Bulk density	55# ft <sup>3</sup>
Vapor Pressure (mm Hg.)	NA	Melting Point	Approx.	1400° C
Vapor Density (AIR = 1)	NA	Evaporation Rate (Butyl Acetate = 1)		NA
Solubility in Water	Insoluble			
Appearance and Odor	Dark tan to light tan powder			

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	NA	Flammable Limits	NA	LEL	NA	UEL	NA
Extinguishing Media	NA						
Special Fire Fighting Procedures	NA						
Unusual Fire and Explosion Hazards	NA						

# Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	None
	Stable	X		

Incompatibility (Materials to Avoid) Hydrofluoric Acid

Hazardous Decomposition or Byproducts None

Hazardous Polymerization	May Occur		Conditions to Avoid	None
	Will Not Occur	X		

# Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic) Acute (short term exposure): cough if exposed to dust levels higher than TLV's. Chronic (long term exposure): may lead to development of silicosis if constantly exposed to dust levels higher than TLV's.

Carcinogenicity: NTP? not listed IARC Monographs? not listed OSHA Regulated? No

Signs and Symptoms of Exposure Long term exposures to dust in excess of TLV's may lead to silicosis

Medical Conditions Generally Aggravated by Exposure Any respiratory illness

Emergency and First Aid Procedures Remove affected personnel from dusty area to clean air

# Section VII — Precautions for Safe Handling and Use.

Steps to Be Taken in Case Material is Released or Spilled Avoid breathing dust, use respirator approved for silica bearing dust. Vacuum or sweep up dust.

Waste Disposal Method Dispose of in sanitary landfill

Precautions to Be Taken in Handling and Storing Use NIOSH MSHA approved respirators for silica bearing dust when dust levels exceed TLV's

Other Precautions If wet down on floors, material will become slippery.

# Section VIII — Control Measures

Respiratory Protection (Specify Type) NIOSH/MSHA approved for silica bearing dusts

Ventilation	Local Exhaust	Yes, if practical	Special	None
	Mechanical (General)	NA	Other	NA

Protective Gloves Not necessary Eye Protection Safety glasses

Other Protective Clothing or Equipment None

Work/Hygiene Practices Good housekeeping as for any inert dusty material



Material Safety Data Sheet  
May be used to comply with  
OSHA's Hazard Communication Standard,  
29 CFR 1910.1200. Standard must be  
consulted for specific requirements.

U.S. Department of Labor  
Occupational Safety and Health Administration  
(Non-Mandatory Form)  
Form Approved  
OMB No. 1218-0072

IDENTITY (As Used on Label and Tag) PETROSET

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate such.

### Section I

Manufacturer's Name Fluid Tech. Inc.	Emergency Telephone Number (702) 871-1884
Address (Number, Street, City, State, and ZIP Code) 4335 West Tropicana Suite #3 Las Vegas, NV 89103	Telephone Number for Information (702) 871-1884
	Date Prepared 11/15/87
	Signature of Preparer (optional)

### Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Mineral dusts	Total dust	15 mg/m3	10 mg/m3*	
including low conc. of crystalline silica	Resp. dust	5 mg/m3	5 mg/m3*	

\*From 1986 ACGIH Hand Book as inert nuisance dust.

### Section III — Physical/Chemical Characteristics

Boiling Point	NA	Specific Gravity (H <sub>2</sub> O = 1)	Bulk density	60#/ft <sup>3</sup>
Vapor Pressure (mm Hg.)	NA	Melting Point	Approx.	1400° C
Vapor Density (AIR = 1)	NA	Evaporation Rate (Butyl Acetate = 1)		NA

Solubility in Water

Insoluble

Appearance and Odor

Light gray, odorless dry powder

### Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	NA	Flammable Limits	NA	LEL	NA	UEL	NA
Extinguishing Media	NA						
Special Fire Fighting Procedures	NA						
Unusual Fire and Explosion Hazards	NA						

# Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	None
	Stable	X		

Incompatibility (Materials to Avoid)

Hydrofluoric Acid

Hazardous Decomposition or Byproducts

None

Hazardous Polymerization	May Occur		Conditions to Avoid	None
	Will Not Occur	X		

# Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No

Health Hazards (Acute and Chronic)

Acute (short term exposure): cough if exposed to dust levels higher than TLV's. Chronic (long term exposure): may lead to development of silicosis if constantly exposed to dust levels higher than TLV's.

Carcinogenicity: NTP? not listed IARC Monographs? not listed OSHA Regulated? No

Signs and Symptoms of Exposure

Long term exposures to dust in excess of TLV's may lead to silicosis

Medical Conditions

Generally Aggravated by Exposure Any respiratory illness

Emergency and First Aid Procedures

Remove affected personnel from dusty area to clean air

# Section VII — Precautions for Safe Handling and Use.

Steps to Be Taken in Case Material Is Released or Spilled

Avoid breathing dust, use respirators approved for silica bearing dust. Vacuum or sweep up dust.

Waste Disposal Method

Dispose of in sanitary landfill

Precautions to Be Taken in Handling and Storing

Use NIOSH/MSHA approved respirators for silica bearing dust when dust levels exceed TLV's.

Other Precautions

If wet down on floors, material will become slippery.

# Section VIII — Control Measures

Respiratory Protection (Specify Type)

NIOSH/MSHA approved for silica bearing dusts

Ventilation	Local Exhaust	Yes, if practical	Special	None
	Mechanical (General)	NA	Other	NA

Protective Gloves

Not necessary

Eye Protection

Safety glasses

Other Protective Clothing or Equipment

None

Work/Hygiene Practices

Good housekeeping as for any inert dusty material.

Material Safety Data Sheet  
May be used to comply with  
OSHA's Hazard Communication Standard,  
29 CFR 1910.1200. Standard must be  
consulted for specific requirements.

U.S. Department of Labor  
Occupational Safety and Health Administration  
(Non-Mandatory Form)  
Form Approved  
OMB No. 1218-0072



IDENTITY (As Used on Label and Use)

Petro-Set II

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name FLUID TECH, INC.	Emergency Telephone Number (702) 871-1884
Address (Number, Street, City, State, and ZIP Code) 4335 West Tropicana Ave., Suite #3	Telephone Number for Information (702) 871-1884
Las Vegas, NV 89103	Date Prepared 4/12/88
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Mineral dusts	Total dust	8.5 mg/m <sup>3</sup>	5.7 mg/m <sup>3</sup> *	
including less than 2.3%		2.3 mg/m <sup>3</sup>	2.3 mg/m <sup>3</sup> *	
Crystalline Silica				
*From 1988 ACGIH Hand Book as inert nuisance dust, containing 2.3% Silica				

Section III — Physical/Chemical Characteristics

Boiling Point	NA	Specific Gravity (H <sub>2</sub> O = 1)	Bulk density	42# / ft <sup>3</sup>
Vapor Pressure (mm Hg.)	NA	Melting Point	Approx.	1400° C
Vapor Density (AIR = 1)	NA	Evaporation Rate (Butyl Acetate = 1)		NA

Solubility in Water

Insoluble

Appearance and Odor

Tan to buff powder

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	None	Flammable Limits	NA	LEL	* NA	UEL	NA
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Extinguishing Media

Foam, dry chemical, water fog

Special Fire Fighting Procedures

None

Unusual Fire and Explosion Hazards

Normal precautions for mineral dusts should be exercised.

- \* In aerosol dust form 70 g/m<sup>3</sup> could flash with spark.

# Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	None
	Stable	X		

Incompatibility (Materials to Avoid)

Hydrofluoric Acid

Hazardous Decomposition or Byproducts

Possibly low levels of Carbon Monoxide and Ammonia

Hazardous Polymerization	May Occur		Conditions to Avoid	None
	Will Not Occur	X		

# Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Yes	Skin?	No	Ingestion?	No
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Health Hazards (Acute and Chronic)

Acute (short term exposure): cough if exposed to dust levels higher than TLV's. Chronic (long term exposure): may lead to development of silicosis if constantly exposed to dust levels higher than TLV's.

Carcinogenicity:	NTP?	not listed	IARC Monographs?	not listed	OSHA Regulated?	No
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Signs and Symptoms of Exposure

Long term exposure to dust in excess of TLV's may lead to silicosis

Medical Conditions

Generally Aggravated by Exposure

Any respiratory illness

Emergency and First Aid Procedures

Remove affected personnel from dusty area to clean air

# Section VII — Precautions for Safe Handling and Use.

Steps to Be Taken in Case Material Is Released or Spilled

Avoid breathing dust, use respirators approved for silica bearing dust. Vacuum or sweep up dust.

Waste Disposal Method

Dispose of in sanitary landfill

Precautions to Be Taken in Handling and Storing

Use NIOSH/MSHA approved respirators for silica bearing dust when dust levels exceed TLV's.

Other Precautions

If wet down on floors, material will become slippery.

# Section VIII — Control Measures

Respiratory Protection (Specify Type)

NIOSH/MSHA approved for silica bearing dusts

Ventilation	Local Exhaust	Yes, if practical	Special	None
	Mechanical (General)	NA	Other	NA

Protective Gloves

Not necessary

Eye Protection

Safety glasses

Other Protective Clothing or Equipment

None

Work Hygienic Practices

Good housekeeping as for any inert dusty material.



MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME

Polymer Drilling Systems  
P.O. Box 507  
El Dorado, AR 71731

TELEPHONE NO.

1-501-836-5707

CHEMICAL NAME ANY SYNONYMS

Hydrous Silicate of Alumina/Wyoming Sodium Bentonite

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT

%

HAZARD DATA

Free Crystalline Silica

1-3

Chronic exposure over the TLV may result in

silicosis or other respiratory ailments.

SECTION III PHYSICAL DATA

BOILING POINT (°F)

Not Applicable

SPECIFIC GRAVITY (H<sub>2</sub>O=1)

2.6

VAPOR PRESSURE (mm Hg)

Not Applicable

VAPOR DENSITY (AIR = 1)

Not Applicable

EVAPORATION RATE

Not Applicable

SOLUBILITY IN WATER

Negligible

APPEARANCE AND ODOR

Yellow, blue, brown granules or powder.  
Earthy odor.

DENSITY @ 20° C:

UNCOMPACTED: 62 lbs/cubic foot

HAZARDOUS MATERIALS IDENTIFICATION

1 Health Hazard

0

Flammability

0 Reactivity

DEGREE OF HAZARD

4 = EXTREME

3 = High

2 = Moderate

1 = Slight

0 = Insignificant

---

SECTION IVFIRE AND EXPLOSION DATA

---

## FLASH POINT

## FLAMMABLE LIMITS

: Applicable

Non Flammable

---

## SECTION V

HEALTH HAZARD DATA

---

## THRESHOLD LIMIT VALUE

Use TLV formula for-crystalline free silica. OSHA permissible exposure limit4 mg/M<sup>3</sup> Total Dust. 1.5 mg/M<sup>3</sup> respirable dust.

Sodium Bentonite Cas. No. 1302-78-9

Free Silica Cas. No. 14808-60-7

---

## EFFECTS OF OVEREXPOSURE

Chronic exposure over TLV may result in silicosis or other respiratory ailments.

## CARCINOGENICITY

IARC, 1987., concludes that there is limited evidence to suggest that over-exposure to crystalline silica (through inhalation) may be carcinogenic to humans.Crystalline Silica/Alpha Quartz has been listed by the IARC as 2A carcinogens.

---

## SKIN

## EYE

## INHALATION

Potential irritant.

Potential irritant.

Irritation to lungs,  
nose, and throat.

---

## EMERGENCY FIRST AID PROCEDURES

ES: Flush with water. SKIN: Wash with soap and water.If inhaled and effects occur, move to fresh air.

---

## SECTION VI

REACTIVITY DATA

---

## CONDITIONS CONTRIBUTING TO INSTABILITY

## INCOMPATIBILITY

Stable

None

---

## HAZARDOUS DECOMPOSITION PRODUCTS

## HAZARDOUS POLYMERIZATION

None

Will not occur.

---

## SECTION VII

SPILL OR LEAK PROCEDURES

---

## STEPS TO TAKE IF MATERIAL IS RELEASED OR SPILLED

If uncontaminated, sweep up or collect. and reuse product.

---

## WASTE DISPOSAL METHOD

Can be disposed of in approved landfill.

---

## NEUTRALIZING CHEMICALS

Not Applicable

---

---

SECTION VIII

SPECIAL PROTECTION INFORMATION

---

RESPIRATORY PROTECTION

Use NIOSH approved dust respirators, with approval TC-21C-XCC.

---

VENTILATION

Sufficient to keep dust levels below the TLV for crystalline silica.

---

PROTECTIVE GLOVES

General duty work gloves.

---

EYE PROTECTION

If high dust conditions exist, tight fitting goggles are recommended.

---

OTHER PROTECTIVE EQUIPMENT

Eyewash

---

SECTION IX

SPECIAL PRECAUTIONS

---

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Store out of the weather. Product becomes slippery when wet. Avoid contact water in walk areas.

---

OTHER PRECAUTIONS

Use

---

---

PREPARED BY: POLYMER DRILLING SYSTEMS

DATE: NOVEMBER, 1988

---

POLYMER DRILLING SYSTEMS  
P.O. Box 507  
El Dorado, Arkansas 71731-0507

BENTONITE



PDSCo Natural Gel, PDSCo High Yield, PDSCo Grcut, and PDSCo Plug, and Granular Sea

## MATERIAL SAFETY DATA SHEET

### SECTION I PRODUCT IDENTIFICATION

MANUFACTURES NAME:

Polymer Drilling Systems

TELEPHONE NO.

(501) 863-5707

ADDRESS:

105 W. Sharp St., P.O. Box 507, El Dorado, AR 71731

### CHEMICAL NAME AND SYNONYMS

Hydrous Silicate of Alumina/Wyoming Sodium Bentonite

### SECTION II HAZARDOUS INGREDIENTS

Material or Component: Free Crystalline Silica

Percentage: 1-8

Hazard Data: Chronic exposure over the TLV may result in silicosis or other respiratory ailments.

### SECTION III PHYSICAL DATA

Boiling Point (F°): Not Applicable

Vapor Pressure (mm Hg): Not Applicable

Evaporation Rate: Not Applicable

Appearance and Odor: Yellow, blue, brown granules or powder. Earthy odor.

Specific Gravity (H<sub>2</sub>O=1): 2.6

Vapor Density (Air=1): Not Applicable

Solubility In Water: Negligible

Density @ 20° C: Uncompacted: 62 lbs/cubic foot

### SECTION IV HAZARDOUS MATERIALS IDENTIFICATION

Health Hazard: 1

Reactivity: 0

Flammability: 0

#### DEGREE OF HAZARD

4 = EXTREME

3 = High

2 = Moderate

1 = Slight

0 = Insignificant



---

#### SECTION V FIRE AND EXPLOSION DATA

---

Flash Point: Not Applicable      Flammable Limits: Non Flammable

---

#### SECTION VI HEALTH HAZARD DATA

---

THRESHOLD LIMIT VALUE: Use TLV formula for crystalline free silica, OSHA permissible exposure limit 4 mg/M<sup>3</sup>. Total Dust, 1.5 mg/M<sup>3</sup> respirable dust.

Sodium Bentonite Cas. No. 1302-78-9  
Free Silica Cas. No. 14808-60-7

EFFECTS OF OVEREXPOSURE: Chronic exposure over TLV may result in silicosis or other respiratory ailments.

CARCINOGENICITY (IARC, 1987., concludes that there is limited evidence to suggest that over exposure to crystalline silica [through inhalation] may be carcinogenic to humans.): Crystalline Silica/Alpha Quartz has been listed by the IARC as 2A carcinogens.

SKIN: Potential irritant.      EYE: Potential irritant.      Inhalation: Irritation to lungs, nose, and throat.

#### EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water.      Skin: Wash with soap and water.  
If inhaled and effects occur, move to fresh air.

---

#### SECTION VII REACTIVITY DATA

---

CONDITIONS CONTRIBUTING TO INSTABILITY: Stable

INCOMPATIBILITY: None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur.

---

#### SECTION VIII SPILL OR LEAK PROCEDURES

---

STEPS TO TAKE IF MATERIAL IS RELEASED OR SPILLED: If uncontaminated, sweep up or collect, and reuse product.

WASTE DISPOSAL METHOD: Can be disposed of in approved landfill.

NEUTRALIZING CHEMICALS: Not Applicable

---

#### SECTION IX SPECIAL PROTECTION INFORMATION

---

RESPIRATORY PROTECTION: Use NIOSH approved dust respirators, with approved TC-21C-XXX.

VENTILATION: Sufficient to keep dust levels below the TLV for crystalline silica.

---

SECTION IX (CONT'D) SPECIAL PROTECTION INFORMATION

---

PROTECTIVE GLOVES: General work gloves.

EYE PROTECTION: If high dust conditions exist, tight fitting goggles are recommended.

OTHER PROTECTIVE EQUIPMENT: Eyewash

---

SECTION X SPECIAL PRECAUTIONS

---

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store out of the weather. Product become slippery when wet. Avoid contact water in walk areas.

OTHER PRECAUTIONS: None

---

PREPARED BY: Polymer Drilling Systems

DATE: July, 1989



## AMERICAN COLLOID COMPANY

One North Arlington • 1500 West Shore Drive  
Arlington Heights, Illinois 60004-1434 • USA  
(708) 392-4600 • Telex ITT 4330321  
Fax (708) 506-6192

218  
101

MATERIAL SAFETY DATA SHEET - May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

Page 1 of 3

PRODUCT NAME: PUREGOLD GEI.

### Section I MANUFACTURER'S INFORMATION

#### Manufacturer's Name & Address:

American Colloid Company  
1500 West Shore Drive  
One North Arlington  
Arlington Heights, Illinois 60004

Emergency Telephone Number: 708-392-4600  
Telephone Number for Information: 708-392-4600  
Date Prepared: January 2, 1990

### Section II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Crystalline Quartz CAS# 14808-60-7	-	-	-	2-6%

#### Respirable Crystalline Quartz

	OSHA PEL	ACGIH TLV	NIOSH	%
present (TWA)	0.1mg/m <sup>3</sup>	0.1mg/m <sup>3</sup> TWA	50ug/m <sup>3</sup> TWA	<2%
proposed (TWA)		50ug/m <sup>3</sup> TWA		

#### Nuisance Dust

Respirable	5mg/m <sup>3</sup>	5mg/m <sup>3</sup>		
Total Dust	15mg/m <sup>3</sup>	10mg/m <sup>3</sup>		

#### \* WARNING:

This clay product contains a small amount of crystalline silica which may cause delayed respiratory disease if inhaled over a prolonged period of time. Avoid breathing dust. Use NIOSH/MSHA approved respirator protection for crystalline silica. The International Agency for Research on Cancer (IARC) (Volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

### PRODUCT IDENTIFICATION

Chemical Name: Bentonite, Acid Leached  
CAS No.: 70131-50-9

FORMULA: Naturally occurring hydrated aluminosilicate of sodium, calcium, magnesium, and iron

HAZARD: Health - 1, Fire - 0, Reactivity - 0, Specific Hazard - See Section VI

Reg. Class: Not Regulated



## AMERICAN COLLOID COMPANY

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Fax (708) 508-6199

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Page 2 of 3

PRODUCT NAME: PUREGOLD GEL

### Section III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not Applicable	Specific Gravity ( $H_2O = 1$ )	- 2.5
Vapor Pressure (mm. hg.)	Not Applicable	Melting Point	- Not Applicable
Vapor Density (air = 1)	Not Applicable	Evaporation Rate (Butyl Acetate = 1)	- Not Applicable
Solubility in water	- negligible		
Appearance and Odor	Fine grey to buff powder or granules, odorless		

### Section IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	- Not Applicable	LEL -	UEL -
Flammable Limits	- Not Applicable		
Extinguishing Media	- Not Applicable		
Special Fire Fighting Procedures	- Inorganic Mineral/Non-Flammable		
Unusual Fire and Explosion Hazards	- Not Applicable		

### Section V REACTIVITY DATA

Stability      Unstable -      Conditions to Avoid - None Known  
                 Stable - X

Incompatibility (Materials to Avoid) - None Known  
Hazardous Decomposition or By-products - None Known

Hazardous Polymerization      May Occur -      Conditions to Avoid - None Known  
   Will Not Occur - X

### Section VI HEALTH HAZARD DATA

Route(s) of Entry:      Inhalation? Yes      Skin? No      Ingestion? No

Health Hazards (Acute and Chronic) - May cause delayed respiratory disease if dust inhaled over a prolonged period of time.

Carcinogenicity:      NTP? No      IARC Monographs? Yes      OSHA Regulated? No

NOTE: The NTP study on the Acute and Chronic Carcinogenic Risk of Silica to Humans (Volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

Signs and Symptoms of Exposure - Excessive inhalation of dust may result in shortness of breath and reduced pulmonary function.

Medical Conditions Potentially Aggravated by Exposure - Individuals with pulmonary and/or respiratory disease including but not limited to asthma and bronchitis should be precluded from exposure to dust.

Emergency and First Aid Procedures - Eyes - Flush with water.  
- Gross Inhalation of dust - Remove to fresh air; give oxygen or artificial respiration if necessary; get medical attention.



## AMERICAN COLLOID COMPANY

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218  
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Page 3 of 3

PRODUCT NAME: PUREGOLD GEL

### Section VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case of Spill or Release or Spilled - Vacuum if possible to avoid generating airborne dust. Avoid breathing dust. wear an approved respirator. Avoid adding water, the product will become slippery when wet.

Waste Disposal Method - Follow federal, state and local regulations for solid waste.

Precautions to be Taken in Handling and Storing - Avoid breathing dust, use NIOSH/MSHA approved respirator where TLV limits for Crystalline Silica may be exceeded.

Other Precautions - Slippery when wet.

### Section VIII CONTROL MEASURES

Respiratory Protection (Specify Type) - OSHA standard 1910.134 or ANSI Z88.2-1980 specification.

Ventilation	- Local Exhaust	- As appropriate	Special	- None
	- Mechanical (General)	- As appropriate	Other	- None
Protective Gloves	- Not Required		Eye Protection	- Recommended
Other Protective Clothing or Equipment	- None			
Work/Hygienic Practices	- Use good housekeeping practices.			

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, American Colloid Company cannot give any guarantee regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.



## AMERICAN COLLOID COMPANY

One North Arlington • 1500 West Shore Drive  
Arlington Heights, Illinois 60004-1434 • USA  
(708) 392-4600 • Telex ITT 4330321  
Fax (708) 506-6199

51401  
51401

MATERIAL SAFETY DATA SHEET may be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

Page 1 of 3

PRODUCT NAME: 1/2" VOICLAY TABLETS

### Section I

### MANUFACTURER'S INFORMATION

Manufacturer's Name & Address

American Colloid Company  
1500 West Shore Drive  
One North Arlington  
Arlington Heights, Illinois 60004

Emergency Telephone Number: 708-392-4600  
Telephone Number for Information: 708-392-4600  
Date Prepared: July 5, 1990

### Section II

### HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Crystalline Quartz CAS# 14808-60-7	-	-	-	2-6%

Respirable Crystalline Quartz

	OSHA PEL	ACGIH TLV	NIOSH	%
present (TWA)	0.1mg/m <sup>3</sup>	0.1mg/m <sup>3</sup> TWA	50ug/m <sup>3</sup> TWA	<2%
proposed (TWA)	-	50ug/m <sup>3</sup> TWA	-	-

Nuisance Dust

- Respirable
- Total Dust

5mg/m <sup>3</sup>	5mg/m <sup>3</sup>
15mg/m <sup>3</sup>	10mg/m <sup>3</sup>

#### \* WARNING:

Inhalation hazard. May cause lung disease if inhaled over a prolonged period of time. Avoid breathing dust. Use NIOSH/MSHA approved respirator where TLV for crystalline silica may be exceeded. IARC Monographs on the evaluation of the Carcinogenic Risk of Chemicals to Humans (Volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.

### PRODUCT IDENTIFICATION

Chemical Name: Bentonite Clay

Chemical Family: Natural Minerals, Montmorillonite

CAS No.: 1302-78-9

FORMULA: Naturally occurring hydrated aluminosilicates of sodium, calcium, magnesium, and iron

HSFA/HMIS: Health - 1, Environment - 2, Reactivity - 0, Specific Hazard - See Section VI

Dot Class: Not Regulated



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PRODUCT NAME: 1/2" VOLCLAY TABLETS

### Section III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not Applicable	Specific Gravity (H <sub>2</sub> O = 1)	- 2.5
Vapor Pressure (mm Hg.)	Not Applicable	Melting Point	- Not Applicable
Vapor Density (AIR = 1)	Not Applicable	Evaporation Rate (Butyl Acetate = 1)	- Not Applicable
Solubility in Water	- Negligible		
Appearance and Odor	Fine gray to buff tablets, odorless		

### Section IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	- Not Applicable	LEL -	UEL -
Flammable Limits	- Not Applicable		
Extinguishing Media	- Not Applicable		
Special Fire Fighting Procedures	- Inorganic Mineral/Non-Flammable		
Unusual Fire and Explosion Hazards	- Not Applicable		

### Section V REACTIVITY DATA

Stability	Unstable - Stable - X	Conditions to Avoid - None Known
Incompatibility (Materials to Avoid)	- None Known	
Hazardous Decomposition or By-products	- None Known	
Hazardous Polymerization	May Occur - Will Not Occur - X	Conditions to Avoid - None Known

### Section VI HEALTH HAZARD DATA

Route(s) of Entry:	Inhalation? Yes	Skin? No	Ingestion? No
Health Hazards (Acute and Chronic) - May cause delayed respiratory disease if dust is inhaled over a prolonged period of time.			
Carcinogenicity:	NTP? No	IARC Monographs? Yes	OSHA Regulated? No
IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans (Volume 42, 1987) concludes that there is "limited evidence" of the carcinogenicity of crystalline silica to humans. IARC classification 2A.			
Signs and Symptoms of Exposure - Excessive inhalation of dust may result in shortness of breath and reduced pulmonary function.			
Medical Conditions Generally Aggravated by Exposure - Individuals with pulmonary and/or respiratory disease including but not limited to asthma and bronchitis should be precluded from exposure to dust.			
Emergency and First Aid Procedures:	Eyes - Flush with water. Gross Inhalation of Dust - Remove to fresh air; give oxygen or artificial respiration if necessary; get medical attention.		



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PRODUCT NAME: 1/2" VOLCLAY TABLETS

### Section VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken in Case Material is Released or Spilled - Vacuum if possible to avoid generating airborne dust. Avoid breathing dust. Wear an approved respirator. Avoid adding water, the product will become slippery when wet.

Waste Disposal Method - Follow Federal, State and local regulations for solid waste.

Precautions to be Taken in Handling and Storing - Avoid breathing dust, use NIOSH/MSHA approved respirator where TLV limits for Crystalline Silica may be exceeded.

Other Precautions - Slippery when wet.

### Section VIII CONTROL MEASURES

Respiratory Protection (Specify Type) - OSHA standard 1910.134 or ANSI Z88.2-1980 specification

Ventilation - Local Exhaust - As appropriate  
- Mechanical (General) - As appropriate

Special - None Required

Protective Gloves - Not Required

Other - None Required

Other Protective Clothing or Equipment - None Required

Eye Protection - Recommended

Work/Hygienic Practices - Use good housekeeping practices.

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, American Colloid Company cannot give any guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.



**APPENDIX K**  
**ACCIDENT REPORT**

**CONTRACTOR  
INCIDENT INVESTIGATION REPORT**

\_\_\_\_\_ Accident\* \_\_\_\_\_ Unusual Occurrence  
\_\_\_\_\_ Injury/Illness\* \_\_\_\_\_ Near Miss

1. Project No: \_\_\_\_\_ Project Phone No: \_\_\_\_\_  
Project Location: \_\_\_\_\_

2. Employee's full name: \_\_\_\_\_ Employee Number: \_\_\_\_\_  
If subcontractor, give name/address: \_\_\_\_\_

3. Address (Home): \_\_\_\_\_  
\_\_\_\_\_  
(Street)  
\_\_\_\_\_  
(City/State/Zip Code)  
\_\_\_\_\_  
(Phone No.)

4. Date of Birth: \_\_\_\_\_ (M/D/Y) 5. Social Security No.: \_\_\_\_\_

6. Job Title: \_\_\_\_\_ 7. Assigned Division: \_\_\_\_\_

8. Date and time of occurrence: \_\_\_\_\_

9. Date and time reported to company: \_\_\_\_\_

10. Date employee began to lose work time: \_\_\_\_\_

11. Estimated/Actual date of return to work: \_\_\_\_\_

12. Describe the apparent extent of injury or illness and parts of body affected (laceration, burn, fracture-rt. lower leg, lt. index finger):  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

13. Describe treatment given (x-ray, stitches, etc.). If hospital or doctor, give name, address, and phone number and attach return-to-work slip:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

14. Did a chemical exposure occur? If yes, what known contaminants were present? What type of exposure occurred? (Inhalation, ingestion, skin contact, etc.):  
\_\_\_\_\_  
\_\_\_\_\_

15. Describe fully how accident happened, give causes and results. Attach another sheet if necessary.  
\_\_\_\_\_  
\_\_\_\_\_

16. Exaction location where incident occurred:

17. Names and addresses of witnesses to the incident:

18. Were emergency procedures adequate?

19. Who was directly supervising the work?

20. Work schedule at time of incident: \_\_\_\_\_ hours per day \_\_\_\_\_ days per week

21. Level of personal protective equipment utilized at time of incident:

(Circle) A - B - C - D

22. What direction or training had been given on the task?

23. How can you or the Company prevent similar incidents from happening again?

24. Did personal protective equipment fail (Tyvek torn, glove ripped, respirator failed, etc.)?  
Describe:

25. What action has or will be taken to prevent similar occurrences:

26. Additional comments:

Signature: \_\_\_\_\_ Date: \_\_\_\_\_  
(Employee)

Signature: \_\_\_\_\_ Date: \_\_\_\_\_  
(Site Supervisor)

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

- Fill out form completely and accurately. Within 24 hours, send a copy of the completed form to the Corporate Industrial Hygiene Manager, Office, Manager, and Administration Manager, send original report to Contractor's Industrial Hygiene Department at the main office location. Retain a copy at the job site.

Attach to report any related information (photographs, doctor slips, witness statements, etc.).

The injured employee shall contact their home division office for further instruction and forms to be completed on work-related injuries/illnesses.

**APPENDIX L**  
**NIOSH METHODS**

## ELEMENTS (ICP)

METHOD: 7300

ISSUED: 2/15/84

M.W.: Table 1

OSHA/NIOSH/ACGIH: Table 1

PROPERTIES: Table 1

ELEMENTS: aluminum	cobalt	manganese	silver	tungsten
arsenic	copper	molybdenum	sodium	vanadium
beryllium	iron	nickel	tellurium	yttrium
cadmium	lead	phosphorus	thallium	zinc
calcium	lithium	platinum	tin	zirconium
chromium	magnesium	selenium	titanium	

SYNONYMS: vary depending upon the compound.

SAMPLING	MEASUREMENT
SAMPLER: FILTER (0.8- $\mu$ m, cellulose ester membrane)	!TECHNIQUE: INDUCTIVELY COUPLED ARGON PLASMA, ! ATOMIC EMISSION SPECTROSCOPY
FLOW RATE: 1 to 4 L/min	!ANALYTE: elements above
VOL-MIN: Table 1 -MAX: Table 1	!ASHING REAGENTS: conc. HNO <sub>3</sub> , 4 mL; ! and conc. HClO <sub>4</sub> , 1 mL ! CONDITIONS: room temperature, 30 min; ! 150 °C to near dryness
SHIPMENT: routine	!FINAL SOLUTION: 4% HNO <sub>3</sub> , 1% HClO <sub>4</sub> , 10 mL
SAMPLE STABILITY: stable	!WAVELENGTH: depends upon element; Table 2
BLANKS: 2 to 10 field blanks per set	!BACKGROUND CORRECTION: spectral wavelength shift
ACCURACY	!CALIBRATION: elements in 4% HNO <sub>3</sub> , 1% HClO <sub>4</sub>
RANGE STUDIED: not studied	!RANGE: 2.5 to 1000 $\mu$ g per sample [1]
BIAS: none identified	!ESTIMATED LOD: 1 $\mu$ g per sample [1]
OVERALL PRECISION ( $s_p$ ): not evaluated	!PRECISION ( $s_p$ ): Table 2

APPLICABILITY: The working range of this method is 0.005 to 2.0  $\mu$ g/m<sup>3</sup> for each element in a 500-L air sample. This is simultaneous elemental analysis, not compound specific. Verify that the types of compounds in the samples are soluble with this ashing procedure.

INTERFERENCES: Spectral interferences are the primary interferences encountered in ICP-AES analysis. These are minimized by judicious wavelength selection, interelement correction factors and background correction [1,2].

OTHER METHODS: This method replaces P&CAM 351 [2] for trace elements. Atomic absorption spectroscopy (e.g., Methods 7000) is an alternate analytical technique for many of these elements.

10/1/90  
24

## ELEMENTS (ICP)

METHOD: 7900

## REAGENTS:

1. Nitric acid, conc.
2. Perchloric acid, conc.\*
3. Ashing acid: 4:1 (v/v)  $\text{HNO}_3$ : $\text{HClO}_4$ .  
Mix 4 volumes conc.  $\text{HNO}_3$  with  
1 volume conc.  $\text{HClO}_4$ .
4. Calibration stock solutions,  
1000  $\mu\text{g/mL}$ . Commercially available,  
or prepared per instrument  
manufacturer's recommendation (see  
step 12).
5. Dilution acid, 4%  $\text{HNO}_3$ , 1%  $\text{HClO}_4$ .  
Add 50 mL ashing acid to 600 mL  
water; dilute to 1 L.
6. Argon.
7. Distilled, deionized water.

\*See Special Precautions.

## EQUIPMENT:

1. Sampler: cellulose ester membrane filter,  
0.8- $\mu\text{m}$  pore size, 3/16-inch diameter; in cassette  
filter holder.
2. Personal sampling pump, 1 to 4 L/min, with  
flexible connecting tubing.
3. Inductively coupled plasma-atomic emission  
spectrometer, equipped as specified by the  
manufacturer for analysis of elements of interest.
4. Regulator, two-stage, for argon.
5. Beakers, Phillips, 125-mL, or Griffin, 50-mL, with  
watchglass covers.\*
6. Volumetric flasks, 10- and 100- mL.\*
7. Assorted volumetric pipets as needed.\*
8. Hotplate, surface temperature 150  $^{\circ}\text{C}$ .

\*Clean all glassware with conc. nitric acid and  
rinse thoroughly in distilled water before use.

SPECIAL PRECAUTIONS: Perform all perchloric acid digestions in a perchloric acid hood.

## SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for a total sample size of  
200 to 2000 L (see Table 1) for TWA measurements. Do not exceed a filter loading of  
approximately 2 mg total dust.

## SAMPLE PREPARATION:

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 5 mL ashing acid. Cover with a watchglass. Let stand 30 min at room temperature.  
NOTE: Start a reagent blank at this step.
5. Heat on hotplate (120  $^{\circ}\text{C}$ ) until ca. 0.5 mL remains.  
NOTE: Some species of Li, Mn, Mo, Sn, W, and Zr will not be completely solubilized by this  
procedure. Alternative solubilization techniques for most of these elements can be  
found elsewhere [2,3,4,5,6,7].
6. Add 2 mL ashing acid and repeat step 5. Repeat this step until the solution is clear.
7. Remove watchglass and rinse into the beaker with distilled water.
8. Increase the temperature to 150  $^{\circ}\text{C}$  and take the sample to dryness.
9. Dissolve the residue in 2 to 3 mL dilution acid.
10. Transfer the solutions quantitatively to 10-mL volumetric flasks.
11. Dilute to volume with dilution acid.

## CALIBRATION AND QUALITY CONTROL:

12. Calibrate the spectrometer according to the manufacturers recommendations.  
NOTE: Typically, an acid blank and 10  $\mu\text{g/mL}$  multi-element working standards are used. The  
following multi-element combinations are chemically compatible in 4%  $\text{HNO}_3$ /1%  $\text{HClO}_4$ :
  - a. Ag, Ca, Co, Mn, Pb, V, Zr,
  - b. Al, Be, Cd, La, Li, Ni, Ti;
  - c. As, B, Ba, Mg, Mo, P, Sn;

METHOD: 7300

ELEMENTS (ICP)

- d. Cu, Fe, Na, Pt, Sr, Te, Y;
- e. Cr, K, Sb, Se, Ti, Zr; and
- f. Si, W (distilled water only)

- 13. Analyze a standard for every ten samples.
- 14. Check recoveries with at least two spiked media blanks per ten samples.

## MEASUREMENT:

- 15. Set spectrometer to conditions specified by manufacturer.
- 16. Analyze standards and samples.

NOTE: If the values for the samples are above the range of the standards, dilute the solutions with dilution acid, reanalyze and apply the appropriate dilution factor in the calculations.

## CALCULATIONS:

- 17. Obtain the solution concentrations for the sample,  $C_s$  ( $\mu\text{g/mL}$ ), and the average media blank,  $C_b$  ( $\mu\text{g/mL}$ ), from the instrument.
- 18. Using the solution volumes of sample,  $V_s$  ( $\text{mL}$ ), and media blank,  $V_b$  ( $\text{mL}$ ), calculate the concentration,  $C$  ( $\text{mg/m}^3$ ), of each element in the air volume sampled,  $V$  ( $\text{L}$ ):

$$C = \frac{C_s V_s - C_b V_b}{V}, \text{ mg/m}^3.$$

## EVALUATION OF METHOD:

Method P&CAM 351 was evaluated in 1981 [1,2]. The precision and recovery data were determined at 2.5 and 1000  $\mu\text{g}$  of each element per sample on spiked filters. The precision and recovery data, instrumental detection limits, sensitivity, and analytical wavelengths are listed in Table 2. The values in Table 2 were determined with a Jarrell-Ash Model 1160 ICP operated according to manufacturer's instructions.

## REFERENCES:

- [1] Hull, R.D. "Multielement Analysis of Industrial Hygiene Samples," NIOSH Internal Report, presented at the American Industrial Hygiene Conference, Portland, Oregon (May 1981).
- [2] NIOSH Manual of Analytical Methods, 2nd ed., V. 7, P&CAM 351, U.S. Department of Health and Human Services, Publ. (NIOSH) 82-100 (1981).
- [3] Ibid, S341 (Lead).
- [4] Ibid, V. 2, S5 (Manganese), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 71-151-B (1977).
- [5] Ibid, V. 4, P&CAM 271 (Tungsten), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 78-175 (1978).
- [6] Ibid, V. 5, P&CAM 173 (Metals by Atomic Absorption), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-141 (1979).
- [7] Ibid, V. 3, S183 (Tin), S185 (Zirconium), and S376 (Molybdenum), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).

METHOD REVISED BY: R. DeLon Hull and Mark Millson, NIOSH/DPSE.

## ELEMENTS (TCP)

METHOD: 7300

Table 1. Properties and sampling volumes.

Element (Symbol)	Properties		Permissible Exposure Limits, mg/m <sup>3</sup> TWA OSHA/NIOSH/ACGIH	Air Volume @ OSHA, L	
	Atomic Weight	MP, °C		MIN	MAX
Silver (Ag)	107.87	961	0.01/ — / 0.1	350	2000
Aluminum (Al)	26.98	660	— / — / 10.	5 (g)	100 (g)
Arsenic (As)	74.92	817*	0.5 (c) 0.002/ 0.2	5	2000
Beryllium (Be)	9.01	1278	0.002/ 0.0005/ 0.002	1250	2000
Calcium (Ca)	40.08	842	5 (b)/ — / 2 (b)	5	200
Cadmium (Cd)	112.40	321	0.2/ 0.04/ 0.05	13	2000
Cobalt (Co)	58.93	1495	0.1/ — / 0.1	25	2000
Chromium (Cr)	52.00	1890	1.0 (c)/ 0.025/ 0.5 (c)	5	1000
Copper (Cu)	63.54	1083	1.0/ — / 1.0	5	1000
Iron (Fe)	55.85	1535	10 (b)/ — / 5 (b)	5	100
Lithium (Li)	6.94	179	0.025 (d)/ — / 0.025 (d)	100	2000
Magnesium (Mg)	24.31	651	15 (b)/ — / 10 (b)	5	67
Manganese (Mn)	54.94	1244	0.5/ — / 0.5	5	200
Molybdenum (Mo)	95.94	651	15 (e)/ — / 10 (e)	5	67
Sodium (Na)	22.99	98	2 (f)/ 0.2 (f)/ 0.2 (f)	13	2000
Nickel (Ni)	58.71	1453	1/ 0.015/ 1 (c)	5	1000
Phosphorus (P)	30.97	44	— / — / 0.1	25 (g)	2000 (g)
Lead (Pb)	207.19	328	0.05/ 0.1/ 0.15	50	2000
Platinum (Pt)	195.09	1769	0.002 (a)/ — / 1 (c)	1250	2000
Selenium (Se)	78.96	217	0.2/ — / —	13	2000
Tin (Sn)	118.69	232	2/ — / 2 (c)	5	500
Tellurium (Te)	127.60	450	0.1/ — / 0.1	25	2000
Titanium (Ti)	47.90	1675	— / — / 10 (b)	5	100
Thallium (Tl)	204.37	304	0.1 (a)/ — / 0.1 (a)	25	2000
Vanadium (V)	50.94	1890	0.5/ 1 (c)/ 0.05 (V <sub>2</sub> O <sub>5</sub> )	5	2000
Tungsten (W)	183.85	3410	— / 5 (e)/ 5 (e)	5 (g)	200 (g)
Yttrium (Y)	88.91	1495	1/ — / 1	5	1000
Zinc (Zn)	65.37	419	5 (b)/ 5 (b)/ 5 (b)	5	200
Zirconium (Zr)	91.22	1852	5/ — / 5	5	200

(a) soluble

(b) oxide

(c) metal

(d) hydride

(e) insoluble

(f) hydroxide

(g) at the ACGIH TLV



METHOD: 7300

ELEMENTS (ICP)

Table 2. Measurement procedures and data (a).

Element	Wavelength (nm)	Instrumental LOD (ng/mL)	Sensitivity (Intensity/ µg/mL)	Recovery (%)		Precision (s <sub>r</sub> ) (N = 3)	
				@ 2.5 µg/ filter (b)	@ 1000 µg/ filter	@ 2.5 µg/ filter	@ 1000 µg/ filter
Ag	328.3	26	0.65	111	91	0.02	0.075
Al	308.2	14	0.23	93	100	0.092	0.023
As	193.7	13	0.51	103	99	0.062	0.026
Be	313.0	1.5	1.29	107	90	0.040	0.034
Ca	315.9	10	0.49	99	95	0.036	0.014
Cd	226.5	1.6	0.83	107	99	0.032	0.020
Co	231.2	7.4	0.38	101	95	0.040	0.005
Cr	205.6	1.3	0.50	98	106	0.053	0.016
Cu	324.8	2.1	0.72	98	99	0.036	0.022
Fe	259.9	3.9	0.13	94	97	0.068	0.016
Li	670.8	2.8	0.48	89	95	0.171	0.043
Mg	279.6	24	0.22	105	106	0.084	0.027
Mn	257.6	0.4	0.74	84	93	0.062	0.035
Mo	281.6	7.0	0.18	94	88	0.023	0.049
Na	589.0	10	0.76	(c)	101	(c)	0.045
Ni	221.6	3.4	0.41	105	97	0.027	0.020
P	214.9	22	0.17	(c)	91	(c)	0.056
Pb	220.4	17	0.42	105	95	0.060	0.011
Pt	203.7	15	0.69	106	91	0.041	0.075
Se	190.6	21	0.28	105	97	0.068	0.049
Sn	190.0	64	0.49	74	67	0.33	0.16
Te	214.3	29	0.41	102	94	0.050	0.063
Ti	334.9	1.2	0.55	96	108	0.051	0.029
Tl	190.9	17	0.22	103	99	0.043	0.017
V	310.2	3.2	0.88	99	94	0.043	0.014
W	207.9	13	2.58	35	23	0.053	0.60
Y	371.0	0.8	2.35	99	100	0.015	0.013
Zn	213.9	0.6	0.60	101	94	0.013	0.013
Zr	339.2	1.9	0.88	75	98	0.049	0.008

(a) Values reported were obtained with a Jarrell-Ash Model 1160 ICP; performance may vary with instrument and should be independently verified.

(b) 2.5 µg/filter corresponds to 5 µg/m<sup>3</sup> for a 500-L air sample.

(c) Blank levels too high to make accurate determinations

## NUISANCE DUST, TOTAL

DEFINITION: Total aerosol mass

METHOD: 0500

ISSUED: 2/15/84

OSHA: 15 mg/m<sup>3</sup>

PROPERTIES: quartz less than 1% [1]

NIOSH: no standard

ACGIH: 10 mg/m<sup>3</sup>, total dust less than

1% quartz

SYNONYMS: boron oxide (CAS #1303-86-2) and nuisance dusts [1] including alumina (CAS #1344-28-1), calcium carbonate (CAS #1317-65-3), cellulose (paper fiber; CAS #9004-34-6), glycerin mist (CAS #56-81-5), limestone (CAS #1317-65-3), etc.

## SAMPLING

## MEASUREMENT

SAMPLER: FILTER  
(tared 37-mm, 5-µm PVC filter)

FLOW RATE: 1.5 to 2 L/min

VOL-MIN: 25 L @ 15 mg/m<sup>3</sup>-MAX: 123 L @ 15 mg/m<sup>3</sup>

SHIPMENT: routine

SAMPLE STABILITY: indefinitely

BLANKS: 2 field blanks per 10 samples

BULK SAMPLE: none required

!TECHNIQUE: GRAVIMETRIC (FILTER WEIGHT)

!ANALYTE: airborne particulate material

!BALANCE: 0.01 mg sensitivity or better; use same  
balance before and after sample  
collection

!CALIBRATION: National Bureau of Standards  
Class M weights

!RANGE: 0.3 to 2 mg per sample

!ESTIMATED LOD: 0.2 mg per sample

!PRECISION: 0.08 mg per sample [3]

## ACCURACY

RANGE STUDIED: 8 to 28 mg/m<sup>3</sup>

BIAS: not significant

OVERALL PRECISION (s<sub>p</sub>): 0.056 [2]

APPLICABILITY: The working range is 3 to 20 mg/m<sup>3</sup> for a 100-L air sample. This method is nonspecific and determines the total dust concentration to which a worker is exposed. It may be applied, e.g., to gravimetric determination of fibrous glass [4] in addition to the other ACGIH nuisance dusts [1].

INTERFERENCES: Organic and volatile particulate matter may be removed by dry ashing [4].

OTHER METHODS: This method is similar to the criteria document method for fibrous glass [4] and Method 5000 for carbon black. This method replaces Method S349 [5]. Impingers and direct-reading instruments may be used to collect total dust samples, but these have limitations for personal sampling.

## NUISANCE DUST, TOTAL

METHOD: 0500

## EQUIPMENT:

1. Environmental chamber at constant temperature and humidity (e.g.,  $20^{\circ}\text{C} \pm 0.3^{\circ}\text{C}$  and  $50\% \pm 5\% \text{ RH}$ ).
2. Sampler: 37-mm PVC, 2- to 5- $\mu\text{m}$  pore size membrane or equivalent hydrophobic filter and cellulose supporting pad in 37-mm cassette filter holder.
3. Personal sampling pump, 1.5 to 2 L/min, with flexible connecting tubing.
4. Microbalance, capable of weighing to 0.01 mg.
5. Vacuum desiccator.
6. Static neutralizer: e.g., Po-210; replace nine months after the production date.

## SPECIAL PRECAUTIONS: None.

## PREPARATION OF FILTERS BEFORE SAMPLING:

1. Dry filters and backup pads under vacuum in the vacuum desiccator for at least 15 min.
2. Release the vacuum, remove the desiccator cover and equilibrate the filters in the environmental chamber for at least 1 hr.
3. Number the backup pads with a ballpoint pen and place them, numbered side down, in filter cassette bottom sections.
4. Weigh the filters in the environmental chamber. Record the filter tare weight,  $W_1$  (mg).
  - a. Zero the balance before each weighing.
  - b. Handle the filter with forceps (nylon forceps if further analyses will be done).
  - c. Pass the filter over an antistatic radiation source. Repeat this step if filter does not release easily from the forceps or if filter attracts balance pan. Static electricity can cause erroneous weight readings.
5. Place the weighed filters on top of the backup pads in the filter cassette bottom sections and allow to stand an additional 8 to 16 hrs in the environmental chamber.
6. Reweigh the filters. If this tare weight differs by more than 0.01 mg from the first tare weight obtained in step 4 above, discard the filter.

NOTE: Insert a rod through the outlet hole of the filter cassette bottom section to raise the backup pad and filter so that the filter can be grasped with forceps.
7. Assemble the filter in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry and mark with the same number as the backup pad.

## SAMPLING:

8. Calibrate each personal sampling pump with a representative sampler in line.
9. Sample at 1.5 to 2 L/min. Do not exceed a total filter loading of approximately 2 mg total dust.

## SAMPLE PREPARATION:

10. Wipe dust from the external surface of the filter cassette with a moist paper towel to minimize contamination. Discard the paper towel.
11. Remove the top and bottom plugs from the filter cassette. Place the filter cassettes in a vacuum desiccator under vacuum for at least 15 min, followed by equilibration for at least 1 hr in the environmental chamber.
12. Remove the cassette band, pry open the cassette and remove the filter. Handle the filters very gently by the edge to avoid loss of dust.

## METHOD: 0500

## NUISANCE DUST, TOTAL

NOTE: If the filter sticks to the underside of the cassette top, very gently lift away by using the dull side of a scalpel blade. This must be done carefully or the filter will tear.

## CALIBRATION AND QUALITY CONTROL:

13. Zero the microbalance before all weighings. Use the same microbalance for weighing filters before and after sample collection. Maintain and calibrate the balance with National Bureau of Standards Glass M weights.
14. Take two to four replicate samples for every batch of field samples for quality assurance on the sampling procedures. The set of replicate samples should be exposed to the same dust environment, either in a laboratory dust chamber [6] or in the field. The quality control samples must be taken with the same equipment, procedures and personnel used in the routine field samples. The relative standard deviation calculated from these replicates should be recorded on control charts and action taken when the precision is out of control.

## MEASUREMENT:

15. Weigh each filter, including field blanks. Record this post-sampling weight,  $W_2$  (mg), beside its corresponding tare weight. Record anything remarkable about a filter (e.g., overload, leakage, wet, torn, etc.).

## CALCULATIONS:

16. Calculate the concentration of total nuisance dust,  $C$  (mg/m<sup>3</sup>), in the air volume sampled,  $V$  (L):

$$C = \frac{(W_2 - W_1) + B}{V} \cdot 10^3, \text{ mg/m}^3$$

where:  $W_1$  = tare weight of filter before sampling (mg)

$W_2$  = post-sampling weight of sample-containing filter (mg)

$B$  = mean change in field blank filter weights between tare and post-sampling (mg) (+ or -).

## EVALUATION OF METHOD:

Lab testing with blank filters and generated atmospheres of carbon black was done at 8 to 28 mg/m<sup>3</sup> [2,6]. Precision and accuracy data are given on page 0500-1.

## REFERENCES:

- [1] TLVs - Threshold Limit Values for 1983-84, Appendix D. ACGIH, Cincinnati, OH (1983).
- [2] This Manual, Method 5000.
- [3] Unpublished data from Non-textile Cotton Study. NIOSH/ORDS/EIB.
- [4] NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Fibrous Glass, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-152, 119-142 (1977).
- [5] NIOSH Manual of Analytical Methods, 2nd ed., V. 3, S349, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).
- [6] Documentation of the NIOSH Validation Tests, S262 and S349, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185 (1977).

METHOD WRITTEN BY: Kathy Morring, Jerry Clere, and Frank Hearl, P.E., NIOSH/ORDS.

FORMULA: The respirable fraction of the dust mass, as specified by the American Conference of Governmental Industrial Hygienists [1]

## NUISANCE DUST, RESPIRABLE

METHOD: 0600  
ISSUED: 2/15/84

OSHA: 5 mg/m<sup>3</sup>  
NIOSH: no standard  
ACGIH: 5 mg/m<sup>3</sup>

PROPERTIES: Penetrates the non-ciliated portions of the lung; quartz less than 1%

SYNONYMS: boron oxide (CAS #1303-86-2) and nuisance dusts [2], including alumina (CAS #1344-28-1), calcium carbonate (CAS #1317-65-3), cellulose (paper fiber; CAS #9004-34-6), glycerin mist (CAS #56-81-5), limestone (CAS #1317-65-3), etc.

SAMPLING	MEASUREMENT
SAMPLER: CYCLONE + FILTER (10-mm Dorr-Oliver cyclone + tared 5- $\mu$ m PVC membrane)	! TECHNIQUE: GRAVIMETRIC (FILTER WEIGHING) ! ! ANALYTE: mass of respirable dust fraction !
FLOW RATE: 1.7 L/min	! BALANCE: 0.01 mg sensitivity or better; use same ! balance before and after sample ! collection !
VOL-MIN: 75 L @ 5 mg/m <sup>3</sup> -MAX: 1000 L @ 5 mg/m <sup>3</sup>	! CALIBRATION: National Bureau of Standards ! Class M weights !
SHIPMENT: routine	! RANGE: 0.3 to 2 mg per sample !
SAMPLE STABILITY: indefinitely	! ESTIMATED LOD: 0.2 mg per sample !
BLANKS: 2 to 10 field blanks per set	! PRECISION: 68 $\mu$ g with 0.01-mg sensitivity ! balance [5] !
ACCURACY	!
RANGE STUDIED: 0.5 to 10 mg/m <sup>3</sup> (lab and field)	!
BIAS: depends on dust size distributions [3]	!
OVERALL PRECISION ( $s_p$ ): 0.043 to 0.145 (lab); 0.144 to 0.227 (field) [4]	!

APPLICABILITY: The method measures the mass concentration of any non-volatile respirable dust. Besides inert dusts [1], the method is recommended for respirable coal dust, which has an OSHA PEL = 2.4 mg/m<sup>3</sup>. The method may be biased where the respirable fraction is defined by the British Medical Research Council's criteria or the MRE horizontal elutriator [4].

INTERFERENCES: Larger than respirable particles (over 10  $\mu$ m) have been found in some cases by microscopic analysis of cyclone filters. Over-sized particles in the sample are known to be caused by inverting the cyclone assembly. Heavy dust loadings, charged particles, fibers and water-saturated dusts also interfere with the cyclone's size-selective properties.

OTHER METHODS: This method is based on and replaces Sampling Data Sheet #29.02 [6].

## EQUIPMENT:

## 1. Sampler:

- a. Filter: 37-mm diameter, 5.0- $\mu$ m pore size, polyvinyl chloride filter or equivalent hydrophobic membrane filter supported with backup pad in a two-piece, 37-mm cassette filter holder held together by tape or cellulose shrink band.
  - b. Cyclone: 10-mm Dorr-Oliver nylon cyclone.
  - c. Sampling head holder: this holder must keep the cassette, cyclone and coupler together rigidly so that air enters only at the cyclone inlet.
2. Personal sampling pump, 1.7 L/min  $\pm$  5%, with flexible connecting tubing.  
NOTE: Pulsation in the pump flow must be within  $\pm$  20% of the mean flow.
  3. Balance, analytical, with sensitivity of at least 0.01 mg. A more sensitive balance will be necessary for substances with PEL's below 1 mg/m<sup>3</sup>.
  4. Static neutralizer, e.g., Po-210; replace nine months after the production date.
  5. Environmental chamber for balance, e.g., 20 °C  $\pm$  0.3 °C and 50%  $\pm$  5% RH.
  6. Vacuum desiccator.

---

SPECIAL PRECAUTIONS: None.

---

## PREPARATION OF SAMPLERS BEFORE SAMPLING:

1. Dry filters and backup pads under vacuum in the vacuum desiccator for at least 15 min.
2. Release the vacuum, remove the desiccator cover, and equilibrate the filters in the environmental chamber for at least 1 hr.
3. Number the backup pads with a ballpoint pen and place them, numbered side down, in filter cassette bottom sections.
4. Weigh the filters in the environmental chamber. Record the filter tare weight,  $W_1$  (mg).
  - a. Zero the balance before each weighing;
  - b. Handle the filter with forceps (nylon forceps if further analyses will be done); and
  - c. Pass the filter over an antistatic radiation source. Repeat this step if filter does not release easily from the forceps or if filter attracts balance pan. Static electricity can cause erroneous weight readings.
5. Place the weighed filters on top of the backup pads in the filter cassette bottom sections and allow to stand an additional 8 to 16 hrs in the environmental chamber.
6. Reweigh the filters. If this tare weight differs by more than 0.01 mg from the first tare weight obtained in step 4 above, discard the filter.  
NOTE: Insert a rod through the outlet hole of the filter cassette bottom section to raise the backup pad and filter so that the filter can be grasped with forceps.
7. Assemble the filters in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette. Place a cellulose shrink band around the filter cassette, allow to dry, and mark with the same number as the backup pad.
8. Remove the cyclone's grit cap and vortex finder before use and inspect the cyclone interior. If the inside is visibly scored, discard this cyclone since the dust separation characteristics of the cyclone might be altered. Clean the interior of the cyclone to prevent reentrainment of large particles.
9. Assemble the sampler head. Check alignment of filter holder and cyclone in the sampling head to prevent leakage.

## SAMPLING:

10. Calibrate each personal sampling pump to 1.7 L/min with a representative sampler in line.
11. Sample at 1.7 L/min for 45 min to 8 hrs (76 to 816 L). Do not exceed 5 mg dust loading on the filter.

NOTE: Do not allow the sampler assembly to be inverted at any time. Turning the cyclone to anything more than a horizontal orientation may deposit over-sized material from the cyclone body onto the filter.

## SAMPLE PREPARATION:

12. Wipe dust from the external surface of the filter cassette with a moist paper towel to minimize contamination. Discard the paper towel.
13. Remove the top and bottom plugs from the filter cassette. Place the filter cassettes in a vacuum desiccator under vacuum for at least 15 min, followed by equilibration for at least 1 hr in the environmental chamber.
14. Remove the filter cassette band, pry open the filter cassette, and remove the filter by inserting a rod in the outlet hole of the filter cassette. Handle the filters very gently by the edge to avoid loss of dust.

NOTE: If the filter sticks to the underside of the cassette top, very gently lift away by using the dull side of a scalpel blade. This must be done carefully or the filter will tear.

## CALIBRATION AND QUALITY CONTROL:

15. Zero the microbalance before all weighings. Use the same microbalance for weighing filters before and after sample collection. Calibrate the balance with National Bureau of Standards Class M weights.
16. Take two to four replicate samples for every batch of field samples for quality assurance on the sampling procedures. The set of replicate samples should be exposed to the same dust environment, either in a laboratory dust chamber [7] or in the field [8]. The quality control samples must be taken with the same equipment, procedures and personnel used in the routine field samples. Calculate precision from these replicates and record  $s_r$  on control charts. Take corrective action when the precision is out of control [7].

## MEASUREMENT:

17. Weigh each filter, including field blanks. Record this post-sampling weight,  $W_2$  (mg), beside its corresponding tare weight. Record anything remarkable about a filter (e.g., visible particles, overloaded, leakage, wet, torn, etc.).

## CALCULATIONS:

18. Calculate the concentration of respirable nuisance dust,  $C$  ( $\text{mg}/\text{m}^3$ ), in the air volume sampled,  $V$  (L):

$$C = \frac{(W_2 - W_1) + B}{V} \cdot 10^3, \text{ mg}/\text{m}^3$$

where:  $W_1$  = tare weight of filter before sampling (mg)

$W_2$  = post-sampling weight of sample-containing filter (mg)

$B$  = mean change in field blank filter weights between tare and post-sampling (mg)  
(+ or -).

## EVALUATION OF METHOD:

1. Bias. In respirable dust measurements, the bias in a sample is calculated relative to the appropriate respirable dust criterion. The theory for calculating bias is developed by Bartley and Breuer [3]. For this method, the bias, therefore, depends on the ACGIH criterion for respirable dust, the cyclone's penetration curve at 1.7 L/min flow rate, and the size distribution of the ambient dust. Based on the cyclone's penetration curves for non-pulsating flow measured with a monodisperse aerosol by Caplan, Doemeny and Sorenson [9], the bias in this method is shown in Figure 1.

For dust size distributions in the shaded region, the bias in this method lies within the  $\pm 0.10$  criterion established by NIOSH for method validation. Bias larger than  $\pm 0.10$  would, therefore, be expected for many workplace aerosols, especially those with small mass median diameters. However, bias within  $\pm 0.20$  would be expected for dusts with geometric standard deviations greater than 2.0, which is the case in most workplaces.

Bias can also be caused in a cyclone by the pulsation of the personal sampling pump. Bartley, et al. [10] showed that cyclone samples with pulsating flow can have negative bias as large as -0.22 relative to samples with steady flow. The magnitude of the bias depends on the amplitude of the pulsation at the cyclone aperture and the dust size distribution. For pumps with instantaneous flow rates within 20% of the mean, the pulsation bias is less than -0.02 for most dust size distributions encountered in the workplace.

Electric charges on the dust and the cyclone will also cause bias. Briant and Moss [11] have found electrostatic biases as large as -50%, and show that cyclones made with graphite-filled nylon eliminate the problem.

2. Precision. In a recent review [4], the overall cyclone precision is shown to be most sensitive to two factors: the analytical precision and the sampling procedures, particularly the quality control system used in the maintenance and calibration of samplers. Theoretically, the variance for the overall precision is the sum of the variances from the sampling and analysis. The analytical variance depends on the dust loading on the filter. For the dust loading in an 8-hr sample above 1.5 mg/m<sup>3</sup>, Bowman, et al. [4] find that the empirically determined sampling error dominates this analytical error.

Because of the effects of the environment, precision estimates for dust samplers are much more variable than those reported for gas and vapor sampling. In laboratory tests with 0.01 mg sensitivity balances, the overall precision of a single respirable dust sample has relative standard deviations ( $s_r$ ) from 0.043 to 0.145 over concentrations ranging from 0.5 to 5 mg/m<sup>3</sup>. In the laboratory studies where the dust concentrations in the test chamber are more carefully controlled, the estimated  $s_r$  is less than 0.091, which is the target precision value for a bias equal to  $\pm 0.10$  in the NIOSH validation criteria.

In the field tests with 0.01 mg sensitivity balances, precision estimates range from 0.144 to 0.227 over concentrations ranging from 1 to 10 mg/m<sup>3</sup>. Whether the larger  $s_r$  values in field tests are due to sampler performance or to more inhomogeneous dust concentrations in the field tests cannot be determined from existing data.



## REFERENCES:

- [1] TLVs - Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1983-84, 38, ACGIH, Cincinnati, OH (1983).
- [2] Ibid, Appendix D, 52.
- [3] Bartley, D. L. and G. M. Breuer. Analysis and Optimization of the Performance of the 10-mm Cyclone, Am. Ind. Hyg. Assoc. J., 43, 520-528 (1982).
- [4] Bowman, J. D., D. L. Bartley, G. M. Breuer and S. A. Shulman. The Accuracy of Sampling Respirable Coal Mine Dust, Draft NIOSH report (1983).
- [5] Parobeck, P., T. F. Tomb, H. Ku and J. Cameron. Measurement Assurance Program for the Weighings of Respirable Coal Mine Dust Samples, J. Qual. Tech., 13, 157 (1981).
- [6] NIOSH Manual of Sampling Data Sheets, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-159 (1977).
- [7] Bowman, J. D., D. L. Bartley, G. M. Breuer, L. J. Doemeny and D. J. Murdock. Accuracy Criteria Recommended for the Certification of Gravimetric Coal Mine Dust Personal Samplers, NIOSH report (in press, 1983).
- [8] Breslin, J. A., S. J. Page and R. A. Jankowski. Precision of Personal Sampling of Respirable Dust in Coal Mines, U.S. Bureau of Mines Report of Investigations #8740 (1983).
- [9] Caplan, K. J., L. J. Doemeny and S. Sorenson. Evaluation of Coal Mine Dust Personal Sampler Performance, Final Report, NIOSH Contract No. PH CPE-r-70-0036 (1973).
- [10] Bartley, D. L., G. M. Breuer, P. A. Baron and J. D. Bowman. Pump Fluctuations and Their Effect on Cyclone Performance, submitted to the Am. Ind. Hyg. Assoc. J. (1983).
- [11] Briant, J. K. and O. R. Moss. The Influence of Electrostatic Charge on the Performance of 10-mm Nylon Cyclones, American Industrial Hygiene Conference (1983).

METHOD WRITTEN BY: Joseph Bowman, Ph.D., CIH, NIOSH/DPSE.

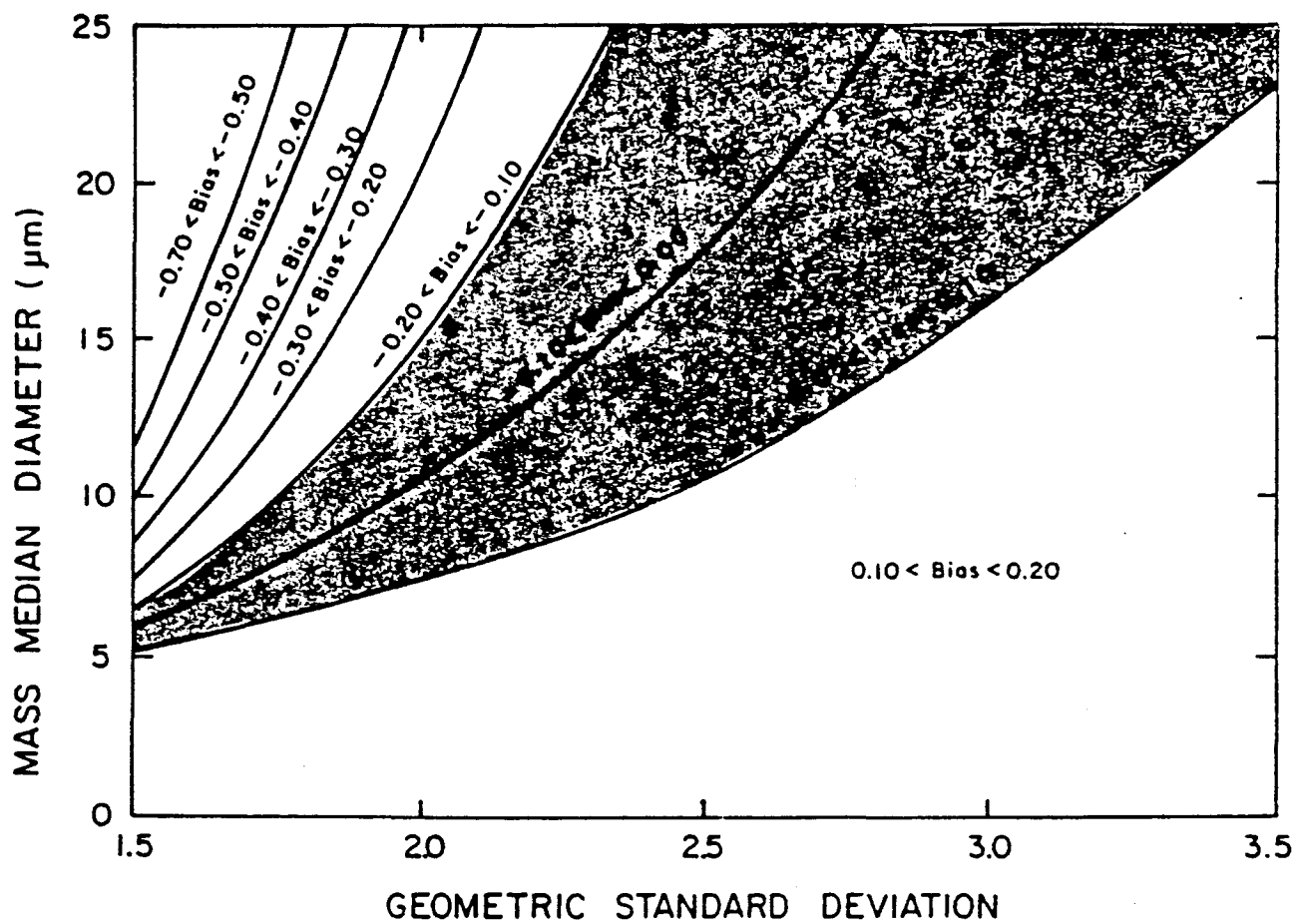


Figure 1. Bias in respirable dust determination.

**APPENDIX M**

**RADIATION WORK PERMIT AND RADIOLOGICAL DEFICIENCY  
REPORT FORMS**

ROCKY FLATS  
RADIOLOGICAL DEFICIENCY REPORT

RDR Number: \_\_\_\_\_  
RWP Number: \_\_\_\_\_  
Occurrence Reporting Number: \_\_\_\_\_

O  
R  
I  
G  
I  
N  
A  
T  
O  
R

DATE: \_\_\_\_\_ LOCATION: (indicate all applicable locations)  
Building \_\_\_\_\_ Room \_\_\_\_\_ Building \_\_\_\_\_ Room \_\_\_\_\_  
TIME: Building \_\_\_\_\_ Room \_\_\_\_\_ Building \_\_\_\_\_ Room \_\_\_\_\_  
Pad \_\_\_\_\_ Pad \_\_\_\_\_ Pad \_\_\_\_\_ Other \_\_\_\_\_

INDIVIDUALS INVOLVED: [ ] Unknown

Name	Employee No.	Org/Company	Job/Classification	Supervisor
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

DESCRIPTION OF EVENT: (Check all that apply. If none apply, check "other" and explain)

<input type="checkbox"/> General Area Contamination	<input type="checkbox"/> Wound (confirmed positive)
<input type="checkbox"/> Personnel Contamination (Skin)	<input type="checkbox"/> Failure to Obtain/Adhere to Pre-evolution
<input type="checkbox"/> Company Clothing Contamination	<input type="checkbox"/> Poor Housekeeping in Controlled Area
<input type="checkbox"/> Personal Clothing Contamination	<input type="checkbox"/> Misuse of Respiratory System
<input type="checkbox"/> Contamination in Uncontrolled Area	<input type="checkbox"/> Radiological Posting Violation
<input type="checkbox"/> Spill Contributing to Area Contamination	<input type="checkbox"/> Dosimeter Lost/Not Worn
<input type="checkbox"/> Loss of Radioactive Sources	<input type="checkbox"/> Improper Use of Radiological Containment
<input type="checkbox"/> Improperly Marked Radioactive Material	<input type="checkbox"/> Improper Disposal of Rad Waste
<input type="checkbox"/> Improper or Lacking Radiological Posting	<input type="checkbox"/> Improper Wearing of Anti-C Clothing
<input type="checkbox"/> ALARA Concerns	<input type="checkbox"/> Improper Frisking of Personnel/Items
<input type="checkbox"/> Exceeding Exposure Limits	<input type="checkbox"/> Potential/Confirmed Inhalation Ingestion
<input type="checkbox"/> Exceeding Exposure Administrative Limit	<input type="checkbox"/> Loss of Containment/Control
<input type="checkbox"/> Procedure Violation/Inadequacy	<input type="checkbox"/> Other _____
<input type="checkbox"/> Rad Work Permit Violation/Inadequacy	
<input type="checkbox"/> Positive SAAM Alarm w/o Respiratory Protection	

DESCRIPTION OF DEFICIENCY: INCLUDE DOCUMENTATION - RWPs, SURVEYS, AIR SAMPLES RESULTS, ETC.  
ANSWER WHO, WHAT, WHEN, WHERE, WHY, AND HOW  
(use additional pages as necessary)

IMMEDIATE CORRECTIVE ACTION:

DOE 5000.3A, CATEGORIZATION: [ ] Emergency	
[ ] Unusual Occurrence [ ] Off Normal	
[ ] Internally Reportable	
OPS Manager: (if applicable)	
EMPLOYEE # _____	DATE: _____

ORIGINATOR: _____	DATE: _____	REVIEWED: RAD OPS FOREMAN _____	EMPLOYEE # _____
EMPLOYEE # _____	TIME: _____	DATE: _____	TIME: _____

R B E	MANAGER RESPONSIBLE FOR CORRECTIVE ACTION: _____	TARGET DATE: _____	RADIOLOGICAL BUILDING ENGINEER _____	DATE: _____
			NAME: _____	TIME: _____

ACTIONS TAKEN INCLUDING THOSE TO PREVENT RECURRENCE:  
(use additional pages as necessary)

I HAVE CORRECTED THIS RDR AND RECOMMEND CLOSEOUT. DATE: \_\_\_\_\_

RESPONSIBLE MANAGER: \_\_\_\_\_ EMPLOYEE #: \_\_\_\_\_

STATUS: [ ] Satisfactory [ ] Unsatisfactory [ ] Redirected	NAME: _____
CONCURRENCE: _____	DATE: _____
APPARENT CAUSE CATEGORY: [ ] Procedures [ ] Communications [ ] Equipment [ ] Training [ ] Personnel [ ] Management Systems [ ] Planning [ ] Other _____	

THIS RDR APPEARS TO HAVE BEEN ADEQUATELY ADDRESSED,  
REQUIRES NO FURTHER ACTION, AND IS CLOSED.

RBE MANAGER: \_\_\_\_\_

DATE: \_\_\_\_\_

☐ EXTENDED

# RADIATION WORK PERMIT

Rocky Flats Plant

NO. :

Date:

Specific Task or Operation

WO/PROCEDURE #

Location: Bldg \_\_\_\_\_ Rm \_\_\_\_\_

Area: \_\_\_\_\_

Supervisor: Phone \_\_\_\_\_

Name: \_\_\_\_\_

Empl # \_\_\_\_\_

Department \_\_\_\_\_

RWP Starts \_\_\_\_\_

Date \_\_\_\_\_

Time \_\_\_\_\_

RWP Ends \_\_\_\_\_

Date \_\_\_\_\_

Time \_\_\_\_\_

## REQUIREMENTS

### Protective Clothing

\_\_\_\_\_ Inspection Only

\_\_\_\_\_ Coveralls

\_\_\_\_\_ Shoe Covers

\_\_\_\_\_ Surgeon Gloves

\_\_\_\_\_ pair

\_\_\_\_\_ Anti-C Coveralls

\_\_\_\_\_ Wet Suit

\_\_\_\_\_ Plastic Booties

\_\_\_\_\_ Rubber Boots

\_\_\_\_\_ Hood

\_\_\_\_\_ type

\_\_\_\_\_ Work Gloves

\_\_\_\_\_ type

\_\_\_\_\_ Tape Openings

\_\_\_\_\_ Other

### Respiratory

\_\_\_\_\_ Full Face, Particulate

\_\_\_\_\_ Full Face, Airline

\_\_\_\_\_ Supplied Air Suit

\_\_\_\_\_ Portable SAAM

\_\_\_\_\_ Lapel Air Sample

### Containment

\_\_\_\_\_ Pen

\_\_\_\_\_ Tent

\_\_\_\_\_ Point Source

\_\_\_\_\_ Air Mover

\_\_\_\_\_ HEPA Vacuum

ALARA REVIEW REQUIRED

Y \_\_\_\_\_ N \_\_\_\_\_

### Dosimetry

\_\_\_\_\_XX\_\_\_\_\_TLD\_\_\_\_\_SRD

\_\_\_\_\_ EXT

\_\_\_\_\_ Other

\_\_\_\_\_ Pre/Post Bioassay

DO NOT EXCEED

\_\_\_\_\_ mRem/individual

on this RWP/day

### Rad Ops Coverage

\_\_\_\_\_ Full \_\_\_\_\_ Start

\_\_\_\_\_ Oncall \_\_\_\_\_ None

### Rad Eng Y \_\_\_\_\_ N \_\_\_\_\_

Name: \_\_\_\_\_

Phone: \_\_\_\_\_

Comments

## SURVEYS

### SURVEY FREQUENCY

Removable	SDWMRONA						
Fixed	SDWMRONA						
mR/hr G	SDWMRONA						
mRem/hr N	SDWMRONA						
N/G Ratio	SDWMRONA						
RPT Name							
Employee #							
Date							
Time							

RO Foreman Signature

Employee #

Date

# RADIATION WORK PERMIT

Rocky Flats Plant

## PERSONNEL ROSTER

RWP # \_\_\_\_\_

N/G RATIO: \_\_\_\_\_

I have read, understand and will comply with Radiation Worker Responsibilities and the requirements of the RWP.

FI	MI	LAST NAME	SIGNATURE	EMPLOYEE #	DATE	Time		AREA	CODE	SRD	Ntrn	** Total
						IN	OUT			Dose	*Dose	

Code: 0 = No Respiratory Protection  
 1= Full Face Respirator  
 2= In-Line Full Face Respirator  
 3= Supplied Breathing Air Garmet

\* Ntrn (Neutron) Dose =  
 SRD Dose (x) N/G Ratio  
 \*\*Total Dose =  
 SRD Dose + Ntrn Dose

RETURN COMPLETED FORMS TO RADIOLOGICAL OPERATIONS